FOURTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF INDIANA

BENJAMIN W. DOUGLASS

1910-1911

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INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1912

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
DECEMBER 5, 1911.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 27, 1911.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

W. H. O'BRIEN,
Auditor of State.

DECEMBER 27, 1911.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, December 27, 1911.

L. G. ELLINGHAM,
Secretary of State.

Received the within report and delivered to the printer, December 27, 1911.

ED D. DONNELL,
Clerk Printing Board.

LETTER OF TRANSMITTAL.

OFFICE OF STATE ENTOMOLOGIST,
BENJAMIN W. DOUGLASS.

INDIANAPOLIS, October 31, 1911.

HONORABLE THOS. R. MARSHALL, *Governor of Indiana:*

My Dear Sir—It is my pleasure to present herewith the fourth report of this department. The report deals with the various activities of the department during the past year, and in addition discusses in detail the subjects of Peach Growing in Indiana, The Scale Insects of Indiana, and The Pests of City Shade Trees. A small part of the report is devoted to the subject of bee keeping in Indiana.

The entire report is the work of the writer and, except in the few cases noted, all of the illustrations have been made in this department. The illustrations presented are considered necessary for a proper understanding of the text.

Respectfully,
BENJAMIN W. DOUGLASS,
State Entomologist.

FINANCIAL STATEMENT.

1910–1911.

Salary—	
Benjamin W. Douglass	$2,500 00
Edna McCormack	800 00
Elsie A Dickson	900 00
Frank N. Wallace	800 00
Everett E. Smith	1,200 00
Daniel W. Erbaugh	1,075 00
George S. Demuth	1,000 00
Harry F. Dietz	356 67
L. S. Hasselman	92 00
Harold Morrison	250 00
Chas. H. Baldwin	281 00
Grace Alexander	206 25
Frank B. Wade	22 50
Clifford L. Bartlett	130 00
Office expense	322 64
Express	711 44
Telephones and telegrams	132 89
Postage	700 00
Hotel	1,094 55
Livery	510 95
Transportation	1,217 32
Total	$14,303 21
Appropriation	$15,000 00
Expenditure	14,303 21
Returned to State	$696 79

An itemized account of all expenditures is on file with the Auditor of State.

INTRODUCTION.

WORK OF THE DEPARTMENT.

During the past year the work of the department has been carried along the usual branches of nursery, orchard and bee inspection.

The orchard and nursery inspection necessitated as usual considerable laboratory work in the way of preparing and identifying specimens. The suggestion has been made that this part of the department's work could be done at Purdue University. Knowing the conditions as I do, I do not hesitate to say that attempt to separate the work as it is now established would be to interfere with a system that has proved to be both economical and efficient. Many specimens are sent in to be identified. These come from the field inspectors and from private individuals all over the State. It is often imperative that the identification be made immediately as a delay would result in a loss of time, money and departmental efficiency.

The laboratory work of the past year was productive of good results in many respects. One of the most notable things was a bit

BROWN TAIL MOTHS.

of work that in itself was but an incidental item but may possibly prove to be the most important to the State. This was the identification of the red-headed fungus, a parasite of San Jose scale. This fungus is well known in some of the Southern States and for the past three years I have been trying to introduce it and its ally the

"black head fungus" into this State. Quite by accident the red-headed fungus was found by one of the deputies, Mr. Frank Wallace, in Seymour, Indiana. Cultures from these specimens were made and tubes of the fungus were sent out during the spring and summer. At this writing it is still too early to know whether the fungus has taken hold in any case, and even if it has it will have to

INSPECTING NURSERY STOCK FROM FRANCE.

stand the test of winter weather to determine whether or not it will be able to live in this climate. The fact that the fungus was found out of doors at Seymour is an indication that the fungus will be adaptable to southern Indiana at least. About three years ago I found another fungus growing on San Jose in Spencer County, but after extensive experiments we were forced to abandon it as we could not get it to produce spores under cultivation.

Another instance of the value of the laboratory work is to be noted in the fact that it was here that the disease known as apple blotch was first identified in Indiana. The first published account of this disease is in my second report. The facts in the case hardly support the charge that the work of this laboratory duplicates the work of any other State department.

During the year a great deal of orchard inspection work was done and a number of demonstration orchards were conducted by the department. Lack of space precludes a detailed account of all

of these orchards, but a few are especially notable. All of the following are in central or northern Indiana, the southern Indiana orchards having failed during the past season.

At Culver the department managed the orchard of Walter Vonnegut, consisting of 50 trees. These trees were pruned early in the spring and were sprayed four times. Every tree in the orchard

A STORAGE CELLAR AT A NURSERY.
An argument against spring planting.

bore to its full capacity and many trees had to be heavily thinned to prevent breaking. One tree of Stark yielded 40 bushels of fine apples. The Fameuse averaged more than 95 per cent. perfect, and other varieties did equally well. This orchard attracted a great deal of attention in the north part of the State.

Dr. Reeder furnished his orchard at Laporte for experimental purposes and in a letter he says, "The results on the orchard are remarkable. Better than the 95 per cent. perfect that you promised me. With the exception of the check trees you can go to any of my trees in the dark and pick and eat an apple without fear of getting a worm."

Perhaps the most remarkable results were had at the orchard of L. V. Hopkins at Maxwell, Indiana. This was a mixed orchard of different varieties and near it was a small orchard of peaches. The peach trees bore for the first time this season. An account of winter

spraying to hold back the peach buds is published elsewhere in this report. The apples gave remarkable yields on all varieties. All of the sprayed trees were full of perfect fruit. The check trees had so little fruit that it was not possible to make a fair comparison.

PILE OF BRUSH REMOVED FROM A SMALL HOME ORCHARD.

It was necessary to go to some neglected orchard in the neighborhood in order to get a good idea of what had actually been accomplished on Mr. Hopkins' place.

One branch of the nursery inspection consists of the examination of all nursery stock that enters the State from abroad or from the States of Missouri or Iowa. In the past year we have examined 2,075,760 trees in the course of this work. Since this work was started three years ago we have found that the quality and condition of the foreign stocks have materially improved. European growers have learned to have more respect for the American planters and are not quite so ready to foist anything upon them that they may chance to have.

An account of the bee inspection work is given under the account of bee keeping in Indiana.

The following list of nurserymen includes all that have received certificates up to the date of this writing, October 27. If there are any familiar names missing it means that those growers have either gone out of business, been refused certificates or have neglected to file necessary affidavits in this office:

LIST OF INDIANA NURSERYMEN.

Abraham Bros., Martinsville, Ind.
Alstott, J. M. & Son, Corydon, Ind.
Anglin, J. K., Etna Green, Ind.
Armstrong, Andrew, Odon, Ind.
Baldwin, T. A., Oxford, Ind.
Barnard, A. J., Westville, Ind.
Barnes, M. & Company, College Corner, Ohio.
Bell, C. A., Borden, Ind.
Bennett, A. S., Lafayette, Ind.
Billingsley, Samuel, Greenwood, Ind.
Bird, E. E., Depauw, Ind.
Brown, James, Borden, Ind.
Brown, Mercer, Spiceland, Ind.
Buck, H. F., Elberfeld, Ind.
Burkhart, H. A. & Son, Southport, Ind.
Burton, S. H., Washington, Ind.
Cain, W. D., Shelburn, Ind.
Callahan, D. W., Pekin, Ind.
Capitol City Nursery Co., Greenfield, Ind.
Card, Phineas A., Greenfield, Ind.
Cathcart, Alva, Bristol, Ind.
Cochran, L. B., Greensburg, Ind.
Collins, Lamar, Underwood, Ind.
Cosner, Alfred, Stilesville, Ind.
Crawford, J. D., Plymouth, Ind.
Cunningham Nursery Co., Rising Sun, Ind.
Davis, George W., Brazil, Ind.
Dean, H. P., Indianapolis, Ind.
Dickson, C. E., Bloomfield, Ind.
Dutter, Jerry, Angola, Ind.
Egloff, Joe, St. Meinrad, Ind.
Flory, A. E., Logansport, Ind.
Fonts, Edward, Borden, Ind.
Gaar, Milton H., Cambridge City, Ind.
Gaar, W. H., Germantown, Ind.
Gainey, S. C., Doans, Ind.
Gallamore, W. F., Bloomfield, Ind.
Garber, D. M., Pierceton, Ind.
Garrett, F. B., Burns City, Ind.
Gast, R. N., Akron, Ind.
Girton, L. R., Bristol, Ind.

Goehler, Albert, Urbana, Ind.
Graham, Charles F., Jeffersonville, Ind.
Graham, John K., New Albany, Ind.
Gray, Alva, Pekin, Ind.
Hanka, Henry, Borden, Ind.
Hazen, Smith, Hatfield, Ind.
Heller Brothers Company, New Castle, Ind.
Henby, J. K. & Son, Greenfield, Ind.
Hill, E. G., Company, Richmond, Ind.
Hobbs, C. M. & Sons, Bridgeport, Ind.
Hofreiter, Andy, New Harmony, Ind.
Hopkins, L. V., Maxwell, Ind.
Hurrow, B. W., Butler, Ind.
Hurst, Louis, Pekin, Ind.
Indiana Experiment Station, The, Lafayette, Ind.
Indianapolis Forest Nursery Co., Greenfield, Ind.
Jackson, Ham, Borden, Ind.
Jarrett, J. A., Montpelier, Ind.
Jones, E. E., Plymouth, Ind.
Keel, Thomas, Westville, Ind.
Keplar, S. W., Pulaski, Ind.
Knaub, Ben, North Vernon, Ind.
Krider, Vernon, Middlebury, Ind.
Lewis, D. C., Fairmount, Ind.
Lucas, J. W., Bloomfield, Ind.
McClaren, Charles A., Corydon, Ind.
McClaren, Joe T., Corydon, Ind.
McCormick & Osborn, Burns City, Ind.
Mason, B. F., Martinsville, Ind.
Meeker, H. H., Crown Point, Ind.
Meredith, Frank, Koleen, Ind.
Milhous, Jessie, Butlerville, Ind.
Miller, Phillip, Borden, Ind.
Mills, Grant, Redkey, Ind.
Moffett, Frank, Carmel, Ind.
Moyer, G. N., Laketon, Ind.
Murr, Asbury, Depauw, Ind.
Murray, A. M., Goshen, Ind.
Nation, Charles, Gilead, Ind.
Neet, G. W., Valparaiso, Ind.
Noble, J. M., Sellersburg, Ind.
Northern Indiana Nursery Co., The, Waterloo, Ind.

Nufer, Alfred, Bremen, Ind.
Osborn, Alfred, Odon, Ind.
Osborn, Arthur, Spiceland, Ind.
Overman, R. J., Danville, Ind.
Palmer, Fred L., Indianapolis, Ind.
Patterson, R. T., Bloomfield, Ind.
Peirce, A. D., Greenfield, Ind.
Portland Nursery Co., Portland, Ind.
Preble, A. C., Marion, Ind.
Quillen, Charles, Monrovia, Ind.
Randolph Nursery Co., W. Lafayette, Ind.
Ragle, Amos, Elnora, Ind.
Rape, T. C., Farmland, Ind.
Reed, W. H., Hanover, Ind.
Ripperdan, Lee, Valley City, Ind.
Robb, G. W., Borden, Ind.
Rogers, Sig, Bloomfield, Ind.
Roerk, B. F., Borden, Ind.
Seibert, A. B., Rochester, Ind.
Shields Brothers, Charlottesville, Ind.
Shields, Thomas & Son, Anderson, Ind.
Sleeper Bros., Fowler, Ind.
Sloan, James, Washington, Ind.
Smith, Joseph E., Muncie, Ind.
Smith, Orin, Butler, Ind.
Snoddy Nursery Co., The, Lafayette, Ind.
Stout, Wilbur C., Mooresville, Ind.
Teas, R. Y. & Son, Centerville, Ind.
Terrell, Grover C., Pekin, Ind.
Thomas, F. G., Battle Ground, Ind.
Young, John J., Odon, Ind.
Walker, F., New Albany, Ind.
Walton, William, Laporte, Ind.
Weaver, Ira, Middlebury, Ind.
Weber, Carl, Greenfield, Ind.
Wines, William H., Akron, Ind.
Wood, W. C., Borden, Ind.

PEACH GROWING IN INDIANA.

When Omar Khayyham sang about his "Book of verses underneath the bough" I have small doubt that the bough he referred to was the branch of a peach tree. In the first place, the peach is a native Persian, and of all fruits the one best calculated to appeal to the fancy of a poet. Like the apple, the peach has come to us from other lands, and has found here not only congenial soil and climate, but intelligent growers who have done much to develop new varieties. We find today that this foreigner is completely naturalized and occupies no mean place in our American horticulture.

A WELL CULTIVATED ORCHARD.

In Indiana, peach growing was an important industry more than two decades ago, large areas being devoted to this purpose. At that time, there were extensive orchards on the hills bordering the Ohio River and for a time they were quite profitable. The growers of that period were unfamiliar with the modern methods of fruit growing and most of the old orchards are now almost forgotten. I have talked with many of the former growers and have visited most of the few orchards that are still standing, and I am

convinced that peach growing in the southern counties can be made far more successful than it was even in the days of the "big orchards."

Most of the old growers attribute their failure to bad luck when, as a matter of fact, it was simply bad management and ignorance of the proper methods of handling this crop. It is probable that Peach Yellows was the most serious drawback to the early orchards as it is to those of the present time. No one can deny, too, that

A TREE IN THE DEAN ORCHARDS IN SOUTHERN INDIANA THREE YEARS OLD.

Peach Yellows is bad enough, but it is not hopelessly bad if the proper steps are taken to control it. The early planters of peach trees in Indiana were of the type that sets out an orchard and allows it to take care of itself, gathering the crops as long as the trees may remain healthy and then hopelessly throwing up their hands as soon as some strange disease makes its appearance.

The men who will be successful in peach growing in Indiana or in any other State, from now on, will be for the most part young men who are willing to adopt the new methods of peach culture and to apply modern methods throughout their work. Men who undertake this work in the proper spirit will have before them a field of tremendous profit and, at the same time, they will find that they are engaged in a most delightful work. It is probable that the man who is looking for a location for a peach orchard will ask, first

of all, about the climate, and it is well that he should for the peach is not a fruit that can be grown in such wide climatic conditions as can the apple. During the past few years the peach crop has been far more certain throughout Indiana than has the apple crop, and with proper care there is no reason in the world why the peach orchard should not yield a crop practically every year.

The chief difficulty in the southern part of the State has been that the winters have not been cold enough to retard the develop-

PEACH ORCHARD CULTIVATED IN CORN.

ment of the peach bud and as a result the buds started out too early in the spring and were caught by the spring frosts. Failures in the extreme north part of the State have been due largely to severe weather in the winter. I would not undertake to grow peaches in any climate where the winter temperature often fell under 5 degrees below zero, although the peach has been known to withstand a temperature of 20 degrees below zero. This, however, is entirely too low a temperature for the commercial peach grower to feel comfortable about. Many peach crops have been lost in the central part of the State by the warm weather in December starting the buds and developing them to a tender stage so that they were readily killed by the severe weather later in the winter.

During the past season I conducted some experiments in an effort to prevent this winter injury. The work was done at several different peach orchards in the central part of the State and the

results were sufficiently encouraging to justify some mention at this time, although they are by no means conclusive. The trees that we experimented with were sprayed with whitewash in December and the spray was repeated as soon as it as worn off or washed off in the rain. The idea was that the white coating of the trees would

YOUNG PEACH ORCHARD CULTIVATED BY GROWING A CROP OF POTATOES.

reflect the light, that the heat would not be absorbed by the branches and that, accordingly, the buds would fail to start. The results showed that the work was correct in theory and there is no reason why it should not be practiced extensively. The peach trees that were whitewashed were retarded to such an extent that they blossomed from ten days to two weeks later than the ones that were not whitewashed. The trees that were whitewashed set nearly 100 per cent. more fruit than the trees that were left for checks. A careful count showed that both the sprayed and the unsprayed trees had to start with about the same number of living buds, so that the work represented a gain of practically 100 per cent. in the possible peach crop.

A different set of weather conditions might change these results materially, so that under some circumstances, the whitewashing might positively be a bad thing. For instance, the buds might be retarded and open just at a critical time and be caught by a late

frost, while the trees that were not sprayed might have passed the critical period and the young peaches be left unharmed. Nevertheless, I believe that the practice of whitewashing of the peach trees is of sufficient value that it should be further experimented with in this State.

THE RESULT OF NEGLECT IN THE PEACH ORCHARD.

I have never tried the use of smudge pots on peaches, but the few trials that I have given this practice on apples and other orchard fruits do not lead me to believe that it will be of great value Indiana. Smudge pots in the apple orchard will be valuable one year in ten and as a result the orchardist must keep up this investment for the other nine years for use during the possible ten. I doubt very much whether the results will pay for this long time investment. This, however, is still altogether in the experimental stage and time may develop that I am wrong in my conclusions regarding the value of artificial heat in the orchard. Aside from affecting the certainty of the crop, the climate has a great deal to do with the quality of fruit, particularly with the quality of peaches.

I am aware that practically every locality in Indiana is just now claiming to grow the finest peaches that can be produced any place; but from my personal observations I would say that the best natural peach districts in this State were along the Ohio River; in

Brown County and in one or two sections in the extreme north part of the State. I am designating these three different localities with the full knowledge that there are many other localities where peach growing has been and can be successfully carried on, and it is probable that I will make some mention of these special localities from time to time throughout this report.

PERFECT ORCHARD CULTIVATION IN THE BROWN COUNTY DISTRICT.

The second consideration in locating a peach orchard is that of soil. The peach tree is somewhat particular as to the character of soil in which it grows. It is not like the apple in this respect. For the most part, peaches seem to do best on sandy soil, and on soil that is well drained. In the southern part of the State the sandy hill tops have been known as the best localities for peach orchards for more than a generation. In the extreme northern part of the State some of the finest peaches are produced on sandy soil so light in character that it is absolutely necessary to maintain an orchard cover throughout the winter to prevent the soil from actually blowing away.

In one peach orchard that I saw in the northern part of the State the trees had been planted and had been mulched close around the tree. The balance of the soil had been left unprotected and as a result the small tree, after the first winter, was left standing on the top of a firm pedestal of sand. Such a light soil is obviously

A BEARING ORCHARD IN THE BROWN COUNTY DISTRICT.

This place has had but little care and still it has produced a profitable crop each year since it started to bear. In this section trees begin to bear when three years of age.

deficient in humus, but this quality can be readily imparted by the growth of proper cover crops.

As a rule, heavy clay soils need to be avoided. The orchard should be located on land which is rolling but is not too steep to allow of thorough cultivation. The soil must be well drained, either naturally or artificially, and if it is not sufficiently fertile, the necessary plant food must be supplied, preferably in the form of commercial fertilizer. It is frequently necessary to fertilize a peach orchard that has come into bearing, as the peach crop tends to exhaust certain elements in the soil. Chief among these perhaps, is potash, which can readily be returned to the soil through the medium of commercial fertilizer. As a rule, I would avoid the use of animal fertilizer in orchards of any sort.

SELECTING THE STOCK FOR PLANTING.

Peach trees are propagated in the nursery by the process known as budding. That is, the seeds are planted in the rows where the nursery trees are to be grown, and when the young seedlings are

THREE YEAR OLD ORCHARD IN JEFFERSON COUNTY.

about two feet high they are budded near the ground with buds taken from trees of the sort that it is desired to propagate. These buds lie dormant until the following year, when the seedling top is cut off and the bud of the desired variety allowed to grow. This

bud grows for one season and produces what we call a normal peach tree. These trees are to be planted at the end of the first season's growth, and any stock offered by the nurseries which is more than one season old should be rejected by the planter.

Older peach trees do not bear transplanting well and there is nothing to be gained by using them. One year old peach trees should measure not more than 5 feet in height and should be about five-eighths of an inch in diameter near the ground. Very frequently nurseries supply a larger size than this, but the larger sizes are not desirable, owing to the fact that they do not stand transplanting so readily, and as a rule do not make so desirable a tree in the orchard. Special care should be given to an examination of the roots before the trees are planted. The peach is subject to crown gall, the same as the apple, and any evidence of this disease on the trees should be carefully watched for. The broken roots should be trimmed off and any unusually long roots should be shortened in.

PLANTING.

There has been a great deal of discussion as to the proper time for planting trees. There are arguments in favor of both spring and fall plantings, but, all things considered, I believe that the best results usually follow the plantings in the spring of the year. There is only one serious objection to this, however. The nurseries, particularly the larger ones, are inclined to dig all of their stock in the fall of the year and store it in their cellars throughout the winter. I have seen nursery cellars piled high with dormant stock and with the roots of the trees about as dry as it is possible for them to get. I do not see how such stock can possibly be expected to live. When it is taken out by the nurserymen in the spring of the year it has every appearance of being normal and very often the roots are puddled in fresh mud before being shipped. This gives them the appearance of having been recently dug from the nursery. The planter will suppose that he is getting normal nursery stock and after giving his trees the best care and attention, he will be surprised that so many of them fail to grow.

I am convinced that the practice of fall digging and winter storage has a great deal to do with many of the failures that I have seen throughout Indiana. I believe that it would be a far better plan for the planter to buy his stock in the fall of the year and carefully heel it in himself and then plant it in the permanent orchard the following spring. Where the nurseryman can be de-

A PEACH CROP IN THE FAMOUS BROWN COUNTY DISTRICT.
In few other sections can peaches be grown with so little care.

AN OLD PEACH ORCHARD THAT HAS BEEN KEPT IN A BEARING CONDITION BY REPEATED HEADING BACK.

pended upon to dig the stock in the spring of the year, I would prefer to let it remain standing in the nursery until the planting time.

The soil in the orchard should be ploughed deep and, when the land is level, should be left exposed during the winter previous to the planting of the orchard. The trees should be planted, for a permanent peach orchard, about 20 feet apart each way. Separate holes must be dug for each tree. These holes should be dug deep enough and wide enough to readily accommodate the roots and to allow the tree to stand a trifle deeper than it stood in the nursery.

The best means of locating the exact place for the tree to stand is to use a wire, stretched the full length of the row in the orchard. At intervals of 20 feet, a loop of brass wire can be soldered to the main wire or a band of white paint can be applied at these intervals. The paint is better because it allows the wire to be handled or coiled more easily. When one row of trees has been planted, the wire is then moved over 20 feet and the next row is planted. In this way, the trees are absolutely kept in line and are checked in both directions.

A few growers prefer to plant their trees 15 feet apart in a row and place the rows 30 feet apart. This is a good plan for a permanent orchard. Such a system of planting allows the planter to grow more intercrop between the trees and renders the cultivation a little bit easier. When the trees become crowded as they mature, it will be easy to cut out every other tree in the row, thus leaving the permanent orchard 30 feet apart. This distance is not too great for the well-cared-for peach orchard.

The old idea that the peach orchard had to be destroyed at the end of the tenth year is now somewhat out of fashion in Indiana. I know of orchards in the southern part of the State that have received intelligent care and are now about twenty-five years of age.

I know of another very successful peach orchard in the Brown County district that was originally planted as a mixed orchard of peaches and apples. At the end of the twelfth year, the owner found that his apple trees had yielded him no commercial crops, while his peach trees had been in successful bearing for several seasons. As he saw it, he could not afford to sacrifice his peaches for a problematical crop on his apple trees. Consequently, the apples that were originally intended for the permanent orchard were destroyed and his peach trees were left. During the past two seasons, his wisdom has been fully demonstrated by the very

excellent peach crop which he has gathered. This orchard is now one of the best I know of in the State and is a model for growers in many respects.

Cultivation in the peach orchard is absolutely necessary from the time that the trees are planted. No other tree requires more thor-

UNCULTIVATED BLOCK AT MASON'S.

A CULTIVATED BLOCK AT MASON'S ORCHARD.

ough culture than does the peach, and cultivation will do more for the prevention of fungus diseases on the peach than almost anything that I know of. It is entirely practical to grow other crops between the rows of trees before the trees come into bearing. Perhaps the best crops for this purpose are those that are low growing, although corn might be grown the first season, after the planting of the trees. I would, also, suggest that small fruits be grown between the rows of peaches. Mr. B. F. Mason has made a great success of his peach orchard by the planting of small fruit plants between the rows of peach trees.

SMALL FRUITS GROWING BETWEEN THE ROWS AT MASON'S ORCHARDS.

The accompanying illustration will give some idea of the results which may be expected from thorough cultivation of the young peach trees. The two photographs were made from the same standpoint, the camera simply being reversed to make the second photograph. In the first case, the trees were left absolutely with no cultivation from the time that they were planted. In the cultivated plat, the trees were planted with raspberry bushes and strawberries between the rows. These small fruits were thoroughly cultivated from the time that they were set out. As the pictures indicate, the uncultivated portion is practically worthless today, while that which has received care is an excellent bearing peach orchard of unusual size for its age, which is four years. These photographs were made on Mr. Mason's farm.

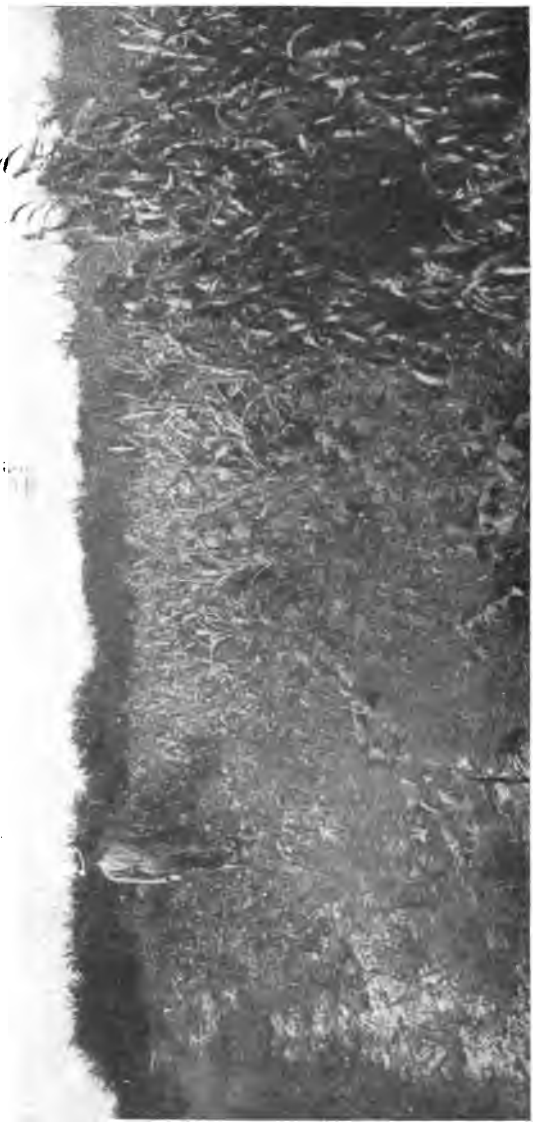
Another grower who has thoroughly demonstrated the value of cultivation in the peach orchard is Mr. L. V. Hopkins of Maxwell, Ind. Three years ago Mr. Hopkins planted an orchard of mixed varieties and the larger part of the orchard has been cultivated from the time that it was set out. Another small corner of Mr. Hopkins' place was left without any cultivation at all, and the accompanying photograph gives some idea of the difference between the cultivated orchard and that portion which was neglected. Mr. Hopkins has found that navy beans and tomatoes make excellent intercrops in his peach orchard. Both of these crops have been

THE WELL KEPT ORCHARD OF B. F. MASON.

planted during the past three seasons and the results of the cultivation of the intercrops have been sufficient to cover all the cost of cultivation and to yield some profit besides. The season of 1911 was the third growing year for Mr. Hopkins' trees and some of the varieties yielded as much as one-half bushel per tree. In the uncultivated part, many of the trees have not only failed to yield any fruit, but many of the trees are dead, and those that remain are simply stunted scrubs.

As soon as the peach orchard comes into bearing a system of permanent cultivation should be adopted, and all attempts to grow commercial crops between the rows should be abandoned. An excellent system to follow in regard to permanent cultivation in the

CULTIVATED BLOCKS AT HOPKINS'—THREE YEARS.



UNCULTIVATED BLOCK AT HOPKINS'—THREE YEARS.

peach orchard is that practiced by Mr. Mason at Martinsville, Ind. The orchard is ploughed in the spring and is kept thoroughly cultivated until the middle of August by being gone over with a spring-tooth harrow about every week or ten days. The latter part of August the cover crop is planted, which may be rye, one of the

THE CROP THAT MR. HOPKINS GOT THE THIRD SUMMER.

clovers, cowpeas or buckwheat. This crop is allowed to grow and remain in the orchard over winter, and is ploughed under some time the next spring. No attempt is made to profit any by this crop

A PEACH TREE IN ITS THIRD SUMMER AT HOPKINS' ORCHARD.

which is grown between the trees, but all of the plant material is allowed to return to the soil, simply serving to enrich the ground and protect it in the winter from the effects of the washing rains.

PRUNING.

Perhaps the most important step in the pruning of a peach orchard is when the young trees are first planted. The peach trees as they come from the nursery are anywhere from three to seven feet in height and probably have innumerable small branches running out from the main stem. Most of the old books on horticulture give illustrations showing the proper methods of pruning such a tree. Almost without exception, these old illustrations show the main stem with a number of short, stubby branches left on it.

Trimming a young tree in such a fashion can not possibly produce the type of peach tree which we desire in our orchards today. It is absolutely necessary that the trees be headed as low as possible, in order to render the work of spraying and harvesting just as easy as possible. At the same time, the tree must not be headed too low or the work of protecting the trunk from borers (and while the tree is young, from rabbits), will be entirely too great.

For most localities in Indiana it is best to trim the trees when they come from the nursery to bare stubs about 18 inches in height. This will form the head of the tree from 12 to 18 inches from the ground, leaving ample room to wrap the tree for protection against rabbits and plenty of opportunity for protection against the peach borer.

In the northern part of the State I think that I would head the trees somewhat higher, owing to the fact that the heavy snows of winter enable the rabbits to reach higher up on the trunk. Consequently, it is necessary to wrap the trees higher than it is in the central and south parts of the State.

One successful grower in the south part of the State recommends that the peach trees be trimmed to an eight-inch stub. I am not in favor of this short pruning, owing to the fact that many branches are developed close to the ground, and, as a result, it is almost impossible to protect such a tree from the work of the peach borer. This matter of protection from the borer will be taken up in detail under its proper heading.

At the end of the first season's growth the young shoots should be cut back from one-half to two-thirds of their length. This is to induce the growth of the succeeding year to branch out and form a compact head as low down as possible. From now on the pruning each year must be planned so as to form open top, vase shaped trees. Trees of this type are able to bear larger loads of fruit without breaking than are the straggly trees of the old peach orchard.

As a rule, it is well to prune peach trees in the spring of the year, and the amount of pruning which is done can often be de-

termined by the condition in which the wood has been left by the cold weather of the winter. If the trees have been injured to such an extent that the buds on the terminal shoots have been killed, it will be well to remove large portions of the growth of the preceding season. This will induce the development of strong, vigorous shoots during the succeeding season of growth and the trees will be that much thriftier for the next year.

In case the trees have passed through the winter in a successful condition, and give promise of bearing a large fruit crop it would be unwise to reduce the fruit-bearing area to any considerable extent. Consequently, we can readily see that the amount of pruning to be done in a peach orchard must be determined, to a certain extent, by the condition in which the trees go through the winter.

Last spring a city man of Indianapolis purchased an orchard in Brown County. The peach trees had been neglected for a number of years and were badly overgrown, many of the trees interlocking with their neighbors. In this particular orchard there were very few fruit buds, indicating that the crop of fruit would be light, and I suggested to the new owner that he "dehorn" the trees. He did not understand the term and I volunteered to demonstrate what I meant if he would get me a saw. I removed practically the whole top of the tree, leaving only some bare stubs about six or seven feet from the ground. The owner of the tree begged me to desist from any further demonstration as he was sure that the tree had been ruined, but after talking with him about the middle of the summer, I learned that the tree which was apparently butchered last spring is now the best looking tree in the entire orchard, and he proposes to treat the balance of the trees in the same way next season. As a matter of fact, the process of dehorning is an exceedingly valuable one in the peach orchard.

I know of one orchard in Harrison County that has been kept in successful bearing for nearly 25 years by the judicious use of this practice. The accompanying illustrations will show the excellent head that the tree grows after being cut back in the way that I have indicated. The pictures will, also, illustrate the extent of cutting back that is necessary to produce such growth. Peach trees cut back in this manner will usually bear fruit on the new growth the season following that in which they are cut back.

It is often desirable in an old, neglected orchard to head back about every other row of trees, leaving the intermediate rows to bear fruit during the year when the dehorned trees are growing the new top.

[3—28403]

READY FOR THE FIRST SPRAYING

SPRAYING.

During the last few years peach growers have come to recognize the fact that it is just as necessary to spray their orchards systematically as it is to spray apple orchards. Formerly it was possible to grow peaches with practically no care along the line of spraying—fruit was perfect without any attention. Recently, however, a number of plant diseases have become common and have rendered it impossible to grow perfect peaches without the application of a spray solution several times during the growing season.

In many sections, the peach leaf curl has become so serious that it requires a special treatment of its own. San Jose scale, while having but little effect on the fruit, is a pest which must be combated in many peach orchards and requires thorough spraying once each year in orchards where it becomes established. For the convenience of the grower, I have formulated a spraying schedule —not a "spray calendar" in any sense of the word—but simply a spraying schedule which can be followed throughout the season and which will guide the grower in the prevention of a large majority of the peach diseases and insects which are liable to occur in Indiana orchards. Some diseases and some insects must receive special treatment and are not included in this spray outline, owing to the fact that they are not universally prevalent throughout the State.

SPRAY SCHEDULE.

First. This application is made before the buds open and while they are still practically dormant. This spraying is to prevent the disease known as peach leaf curl—a fungous disease affecting the leaves and which is carried over the winter in the form of spores located on the twigs. This spraying, like all others, must be exceedingly thorough if good results are to follow. The solution recommended is either a Bordeaux solution made with 6 pounds of copper sulphate, 4 pounds of lime and 50 gallons of water, or a lime and sulphur solution made as follows: 15 pounds of lime, 15 pounds of sulphur and 50 gallons of water; the whole to be boiled for at least 30 minutes. As a substitute for this lime and sulphur solution, a commercial lime and sulphur solution may be employed which is made as follows: Concentrated commercial lime and sulphur, 1 gallon; water, 12 gallons.

Second. This spray is applied just after the calyx sheds from the young peach. It will be noted that after the petals fall from

young peaches, the small calyx cup or husk falls off some time later. This usually happens after the young peaches are well formed and as soon as they begin to grow. The spraying at this time is to prevent the work of the plum curculio and, also, the early infection of the peach scab. The solution that should be used at this time consists of the self-boiled lime and sulphur solution made as follows: 8 pounds of lime, 8 pounds of sulphur and 50 gallons of water. The lime and sulphur are to be placed in a barrel and about 10 gallons of hot water are to be added to them. This solution is allowed to cook for about 20 minutes, simply by the heat generated from the slacking lime. At the end of 20 minutes, the additional 40 gallons of water is added to make the solution up to full strength of 50 gallons. To this 50 gallons of lime and sulphur solution should be added 1½ pounds of arsenate of lead. The arsenate of lead is employed as a poison for the curculio and other leaf-eating insects.

Third. This spraying is simply a repetition of the second in all respects and is made to cover up any deficiencies of the second spraying. It is possible that if the second spraying be applied very thoroughly over a large area that the third spraying might be omitted; but these ideal conditions are hardly obtainable in any peach orchard in Indiana. Consequently, this third spraying is recommended. It is applied ten days or two weeks after the second spraying.

Fourth. This spraying is made at about the time the peaches start to color, and on some of the early ripening varieties this fourth spraying may be omitted. On all main crop sorts and late varieties, the spraying should be applied without fail. It is designed primarily to prevent further infection of the peach scab and to prevent the development of the fungus which produces the brown rot on the peach. The self-boiled lime and sulphur should be employed, but the arsenate of lead may be omitted at this time. It will be noted that in the last three sprayings the self-boiled lime and sulphur solution has been recommended. The commercial lime and sulphur solution has not given entire satisfaction as a summer spray for peaches, although it is all that we can desire as a fungicide in the apple orchard. In a few cases the commercial lime and sulphur solution has yielded splendid results on peach trees and has produced absolutely no injury, but on other orchards considerable injury has resulted. Last spring some of the apple orchardists in Indiana who had been well pleased with the use of the commercial lime-sulphur solution on their apples tried the same

solution on the peach trees, using a dilution of one to forty (1-40). I know of a number of cases where this strength was used and absolutely no damage resulted to the peach trees. On the other hand, I have a report from the eastern part of the United States where a dilution of one to one hundred and twenty-five (1-125) resulted in complete defoliation of the trees. It will be seen that there is much to be learned regarding the behavior of these commercial lime-sulphur solutions.

VARIETIES.

In the following list of varieties, I have tried to include those that were best adapted for commercial growing in Indiana. I have, no doubt, left out quite a number of varieties that are favorites with some, but the following list includes the sorts that are recommended by the largest number of successful growers in this State. I have taken the liberty of including one or two new varieties that have originated in Indiana and that give more or less promise of being successful commercial sorts. The peach is not a fruit that adapts itself to new conditions, and very often the sorts which originate in a locality prove to be valuable commercial varieties for that section. This is notably true of the peach known as the Burgess Cling or the Hoosier Cling, which will be discussed more fully under its proper heading. The following list of varieties is arranged in the order in which the peaches ripen. Each description will be followed by initials which indicate the section of the State where the variety will be expected to do the best, the initials S., C. and N. being used to indicate south, central and north sections. All of the peaches described are free stones except where the word cling is included as a portion of the name of the variety:

Mountain Rose.—This is one of the very best early varieties which can be grown in the southern part of the State for market purposes. The fruit is quite large, round and entirely free. The flesh is white and exceedingly juicy and of fine quality. In color, the skin of the peach is white with a red blush on the side next to the sun. The variety originated in New Jersey, but has shown itself to be adapted to our southern Indiana hills. Some of the finest fruit I have ever eaten were Mountain Rose peaches grown in the hills of Brown County. S.

Champion.—By many growers the Champion is regarded as the best early market peach. The fruit is very large, the skin is creamy white with a red cheek next to the sun. The flesh is white, juicy,

and the quality is excellent. This is one of the hardiest varieties that we have among the early peaches. The variety originated in Illinois and is adapted to practically all sections of the State, being one of the extremely valuable varieties for its season.

Old Mixon Free.—This hardy peach is popular with a great many growers. The fruit is large, slightly oval in shape and somewhat lopsided. The skin is pale yellow marked with red; the flesh tender and rich with a deep red color at the stone. This is one of the valuable main crop peaches and has shown itself to be a valuable sort for southern Indiana, although it is sufficiently hardy to be planted throughout the State. N. C. S.

Stump.—This variety is very similar to the Old Mixon Free, but ripens a little later. It is also a valuable market sort and can be planted to follow up the preceding. N. C. S.

Crawford's Early.—This variety is almost universally recommended by growers throughout Indiana. The fruit is very large, oval in shape with sharp pointed apex. The skin is yellow marked with red. In quality, the early Crawford is subacid and juicy. As a general thing, this sort has shown itself to be a good bearer and very reliable—producing crops of fruit when other varieties failed. It is recommended especially as an excellent market sort for the entire State. The variety originated in New Jersey. N. C. S.

Crawford's Late.—This large yellow peach has not so good a record as the Crawford's Early and is not recommended for wide planting in Indiana. A few growers still regard it as a choice sort, and continue to plant a certain portion of the trees. The variety also originated in New Jersey.

Elberta.—The Elberta has been termed the Ben Davis of the peach tribe. In quality, the fruit is not so good as many other peaches, but the variety is exceedingly reliable, and as a rule the Elberta trees will bear when everything else fails. The tree is a strong grower and quite hardy. The fruit, while of medium size, is usually of an attractive color, being yellow with a blush on the sunny side. The flesh is tender and juicy although the quality is not the best.

One thing which makes the Elberta a valuable market sort is the fact that the fruit can be picked green and will ripen off the trees. This one fact has made the Elberta one of the most profitable varieties in this and other States. N. C. S.

Smock.—This variety is another sort that originated in New Jersey. It ripens late, the fruit is large, oval in shape; the skin is yellow marked with red. The flesh of the Smock is yellow and

the center next to the stone is red. The quality of the peach is not so good as some, but the fact that it is reliable has made it a good sort for the market. N. C. S.

Salway.—This peach of English origin has developed into one of the very best varieties for growing in Indiana. The fruit is large, roundish in shape with a yellow skin blushed with red. The flesh is yellow and the center is red. In quality, the Salway is one of the best, the flesh being sweet, juicy and of fine flavor. Altogether, this is probably the very best late peach that we have, for it is not only fine in quality but sufficiently firm to make it an excellent shipper. It is especially recommended for the central and southern parts of the State.

Engle's Mammoth—This peach is recommended by some growers for the northern part of the State, it having developed quite a reputation among the peach orchards in Michigan. It is especially prized as a peach for canning purposes and is recommended for this purpose. The peach is large with a red cheek; the quality is excellent. N.

Kalamazoo.—This variety originated in Kalamazoo, and attracted attention by bearing regular crops of large fruit of highest quality in a locality where the peach is considered a failure. It is a wonderfully strong grower, bears full loads of fruit at two years old, and sets an enormous amount of fruit. Its size equals Early Crawford, more uniform but small; superb quality, flesh thick, and yellow in color. The skin is golden yellow with light crimson cheek. The fruit ripens between the Early and Late Crawford.

Hoosier Cling.—This variety should be known as the Burgess Cling having originated on Mr. Burgess's farm near DePauw, Indiana. Mr. Burgess's description of the peach follows: "It originated on the Burgess farm, hence the name. It has been in existence for forty-five or fifty years, and is a white meated peach with a blush on one side. It varies in size from $2\frac{1}{2}$ to 3 inches in diameter. For canning purposes it is one of the best if not the best in the world. It keeps well in shipping. It is an excellent bearer, is of fine flavor, sweet and juicy. It ripens about the first of September and is a well known peach in Harrison and adjoining counties."

Heath Cling.—This white peach is one of the very best of its season, which is late, but unfortunately it is not a dependable bearer and can not be recommended for commercial planting. In some sections of the south, however, it has proved to be a good commercial sort.

Hopkins Favorite. This name has been given to a peach that seems to have originated with Mr. L. V. Hopkins, of Maxwell, Indiana. The fruit is of medium size, well colored and quite free. Though new, it promises to be a good market peach for the central Indiana section, where it originated.

THE ORIGINAL TREE OF THE "HOPKINS FAVORITE".

INSECTS INJURIOUS TO THE PEACH.

Professor A. L. Quaintance of the United States Department of Agriculture states that 190 species of insects attack the peach. Comparatively few of these, however, are of any importance; but those few produce an injury of several million dollars per annum. During the last few years, the more important insects affecting the peach have apparently increased in number, and as a result peach growing has not yielded the profit which was formerly credited to that industry. While the insects affecting the peach can not be controlled with the same ease that the insects affecting the apple can be controlled, they can be held in check to such an extent that the business of growing peaches still remains one of the most profitable branches of horticulture. The intelligent, careful grower need not hesitate to plant peach orchards, provided he is willing to enter into the matter in a scientific way and is prepared to fight the various injurious insects from the time that the orchard is planted.

COCOONS AND PUPAE OF THE PEACH BORER.

INSECTS AFFECTING THE TREES.

PEACH BORER—(Sanninoidea exitiosa.)

The peach borer is recognized as the most injurious insect affecting the peach tree that we have to combat. It is a native insect and the injury which it causes annually mounts into the

thousands of dollars. "Its native food plant is thought to have been the wild cherry and possibly, also, the wild plum. With the introduction of the peach by the early settlers, this plant soon became its favorite food, and complaints of its destructiveness are frequent in our early horticultural literature. It is now known to infest various cultivated varieties of stone fruit, the apricot, nectarine, prune and plum, but it is preëminently destructive to the peach." (A. L. Quaintance.)

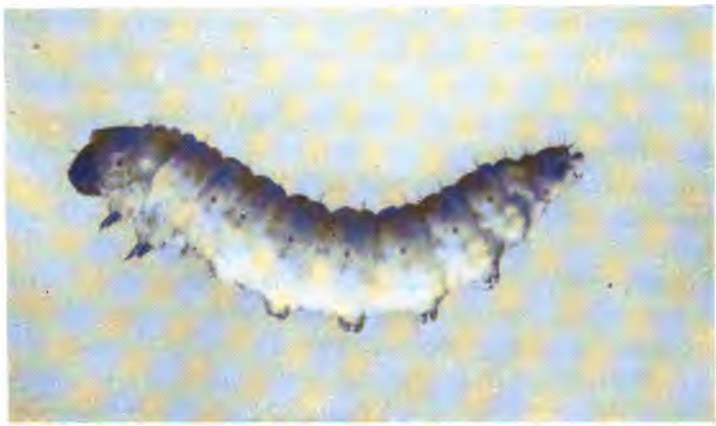
LARVA OF PEACH BORER.
(Natural size.)

The borers will attack the peach tree at any age, but as a rule, are more destructive to the young trees. This is due, probably, to the fact that the young trees, being smaller, are more seriously injured by the work of the insects, than are the large, vigorous trees that are in the older, well cared for orchards. One or two borers in a one-year-old tree can very easily kill the tree, while old trees sometimes manage to live even when they harbor as many as fifty or sixty separate insects. The peach borer usually attacks the tree at or near the surface of the ground, and the grub or larva excavates a burrow just under the bark in the growing tissues. The peach tree usually exudes quite a quantity of gum at the point of the injury in an effort to overcome the effect of the borer. In wet weather, this mass of gum sometimes swells to considerable size and in badly infested young trees I have seen a quantity of gum equal to about a quart laying around the tree at the surface of the ground.

The insect is very often met with in the nursery and the planter of the peach trees should examine his stock for its presence. No tree should be planted which might be suspected of harboring peach borers, and any badly injured trees should be rejected. No reputable grower will send out peach trees that have been badly injured by this pest or that are, by any chance, infested with the insect.

Several years ago, it was necessary for me to refuse a certificate for the sale of a large block of peach trees grown by one of

the large nurseries in this State but whose headquarters were in Ohio. In my examination of the stock in the field, I was unable to find any trees that were not affected with the borers, and condemned the entire block. Later the proprietor of the nursery in-



PEACH BORER ENLARGED.

formed me that he had about a carload of trees dug that he was sure were entirely free from the insect and requested that a special inspection be made of this particular car lot. I made a special inspection of the trees in his packing house and condemned about

PEACH TREE WITH EARTH HILLED UP AS A PREVENTATIVE OF BORER INJURY.

20 per cent. of those that he had pronounced absolutely free from borers. Of this 20 per cent., all of the trees were girdled more than 50 per cent. of the distance around the stem. Some trees that were only slightly injured were allowed to pass in this lot, after the borers had been carefully dug out and destroyed. This lot of condemned trees had already passed inspection by the Ohio inspector and the owner was somewhat indignant at the thoroughness of the Indiana inspection.

About three years ago I visited the orchard of Mr. John Billheimer in Brown County, and was very much surprised to find that no preventive measures had been taken to prevent the work of the peach borer and that no work was being done to dig out the grubs that might be in the trees. The owner informed me that he did not believe that he had any peach borers in his orchard, but a very slight examination was sufficient to reveal the presence of borers in practically every tree on the place. In this orchard I saw what I believe to be the worst cases of peach borers that I have ever seen in young trees. Some of the trees were already dead at the time of my visit, but their death had been attributed to other causes. The planter of a young orchard can not be too careful in the selection of his stock and in the care of it after it is planted. No tree should be planted that is not absolutely perfect in every way and in ordering trees from a nursery, this point should be made perfectly clear to the owner of the nursery before the order is given.

Life History.—The peach borer winters in the larval stage and most of the grubs remain in their channels under the bark. Some of the smaller worms come to the surface and construct cells in which they hibernate during the winter. Early in the spring the larvae start eating again and pupate about May the first. The pupal condition lasts about one month, the adults beginning to emerge early in June, and continue to emerge until about the middle of September. This accounts for the fact that we ordinarily find the worms present in the peach tree in various sizes during the spring and fall. There is but one brood each year. The eggs are laid from early summer until September. The single brood does not all appear at one time and, in effect, we have innumerable overlapping broods appearing throughout the summer. The long period of egg laying makes the insect that much more difficult to control. The eggs are laid on the trunks of the trees and as soon as the young larvae hatch they at once burrow beneath the bark and begin feeding on the tender tissues.

A great many preventatives have been tried, but very few of them have shown to be of any value. Practically all of the preventatives in the nature of solutions sprayed on the trees have not only failed to accomplish any good results but some of them have been positively injurious. Practically the only method of controlling this injurious insect is to cut out and destroy the borers each spring.

Some growers practice the worming of the trees, as they call it, in both the spring and fall and supplement their work by mounding up the earth around the trees in the first part of June and allow the earth to remain until September. This mound of earth should be about a foot high and it serves to cause the borers to enter the tree higher up than they ordinarily would. When the earth is removed in September the work of the young borers can readily be seen and they can be dug out at that time and destroyed, thus greatly reducing the labor of worming the trees. This method of control has given entire satisfaction in a large number of Indiana orchards.

The sources of infestation should be looked after as closely as possible and any badly neglected and infested trees in the neighborhood should be removed.

LESSER PEACH BORER—(Aegeria pictipes.)

This borer is similar to the last, but the moth is somewhat smaller and attacks the trunk and larger branches. It is not a serious pest in a well cared for orchard and has been reported from only a very few places in Indiana. Wherever it occurs, it is necessary to employ the same methods for its eradication as have been recommended for the control of the peach borer.

FRUIT TREE BARK BEETLE—(Scolytus rugulosis.)

This small, black beetle bores a hole in the bark and digs out a brood chamber about an inch and a half in length and usually parallel with the tree. In this brood chamber the eggs are laid and the young grubs make feeding tunnels at right angles with the brood chamber. In this way the tree is soon girdled. There are several generations of the insect annually and when it attacks a tree it usually makes short work of it. It is not an insect to be feared by the careful grower, owing to the fact that it never attacks a perfectly healthly tree, but only trees that have been weakened by some other cause.

WORK OF THE FRUIT TREE BARK BEETLE.

When the young beetles first attack the tree the evidence of their work is to be found in masses of gum which are exuded along the branches where they are working. Later when the adults emerge from the tree they come out through a round, circular hole about the size of a number 8 shot, and a badly infested tree has the appearance of having been shot with a shotgun. Whenever the insect is found to be at work in the tree the weakening cause which led to the infestation by the fruit tree bark beetle should be sought for and, if possible, removed.

It is doubtful, however, if any tree can be saved which is once attacked by these small beetles, and when their presence is noted the tree should be cut and burned at once. The burning should not be neglected. It is not sufficient simply to cut the tree and let it lay on the ground, for it will continue to be an excellent breeding place for the beetles, and it is entirely possible to imagine a condition wherein this beetle might attack practically healthy trees, should the insects occur in sufficient numbers and find no suitable breeding place in the shape of weakened trees.

For San Jose Scale and other scale insects, see article on "Scale Insects of Indiana."

PLUM CURCULIO—(Conotrachelus nenuphar.)

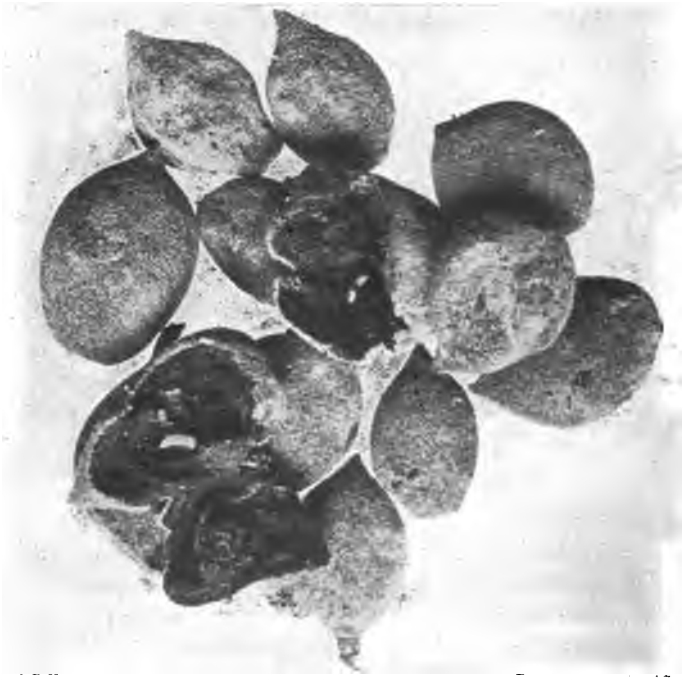
This insect and its close relative, the apple curculio, are the two worst enemies to fruit growers in Indiana. The injury caused

EFFECT OF PLUM CURCULIO.

is not only severe but exceedingly difficult to control. The plum curculio attacks not only the plum but, to a very large extent, the peach, the various other stone fruits, and frequently the apple.

In controlling it in an orchard, it is necessary to employ various means. Clean culture in the orchard will go a long ways

PLUM SHOWING CHARACTERISTIC INJURY OF THE CURCULIO.
(After U. S. Dept. Agr.)



PEACHES SHOWING WORK OF CURCULIO.
(After U. S. Dept. Agr.)

toward preventing injury from this beetle as the adults hibernate during the winter in rubbish laying on the ground.

In some sections jarring the trees is practiced to collect the adult beetles before they begin to lay their eggs in the spring. In this work a curculio catcher is employed, which consists simply of

PLUM CURCULIO AT WORK ON A YOUNG PEACH.
After U. S. Dept. Agr.)

a sheet spread on the ground and a long padded pole with which the trees are jarred. The beetles have a habit of "playing possum" when they are disturbed and as soon as the tree is jarred they let go all hold and fall to the ground, where they are readily gathered up in the sheet and destroyed. Various forms of curculio catchers have been devised and a few simple forms are illustrated herewith. The adult is known to be a very scant feeder in the spring of the year and, theoretically, spraying with any arsenical poison will not greatly benefit the situation. It is a well known fact, however, that sprayed orchards are far freer from curculio injury than orchards that are not sprayed.

From practical experience in the matter, I believe that I would about as soon trust to control this insect with spraying as with the jarring method practiced so widely in some other sections. Spray-

ing and cultivation have accomplished so much in our orchards in other ways that I have great confidence in the ultimate success of these measures in the control of this rather difficult pest.

Life History.—The curculio winters in the adult stage. The

PEACH SHOWING LARVA OF PLUM CURICULIO.
(After U. S. Dept. Agr.)

CURCULIO CATCHERS IN GEORGIA.
(After U. S. Dept. Agr.)

A CURCULIO CATCHER.
(After U. S. Dept. Agr.)

PERFECT CULTIVATION LEAVES NO PLACE FOR THE CURCULIO.

beetle is a stout, heavily built insect about one-fourth of an inch or less in length; dark grey in color and marked with white and black. There are four prominent humps on the wing cover which serve to distinguish the beetle from any other snout beetle in the orchard. The adult beetles become active at the approach of spring and egg laying starts when the young fruit has set. The adults cut crescent-shaped slits in the fruit and the eggs are laid in this

EFFECT OF CODLING MOTH IN PEACH.

crescent-shaped slit, so that the young larva is entirely out of the way of any arsenical poison as soon as it hatches. The eggs hatch in about a week, though this time varies according to the season.

YOUNG PEACH BUGS SHOWING DIFFERENT SIZES IN THE DEVELOPMENT.

Adult shown in another picture.

The larva is a "slightly reddish white grub, with rather sparse, bristling, yellowish brown hair and a small, yellowish brown head. It is nearly one-half inch in length and is quite active." (J. B. Smith.)

The first adults emerge in July and almost at once fall to the ground where they remain the balance of the summer, and throughout the winter.

A "TRUE BUG" THAT INJURES PEACHES.
(Nazara hilaris Say.)
This insect was found doing considerable damage to growing peaches at Indianapolis during the summer of 1911.

DISEASES OF THE PEACH.

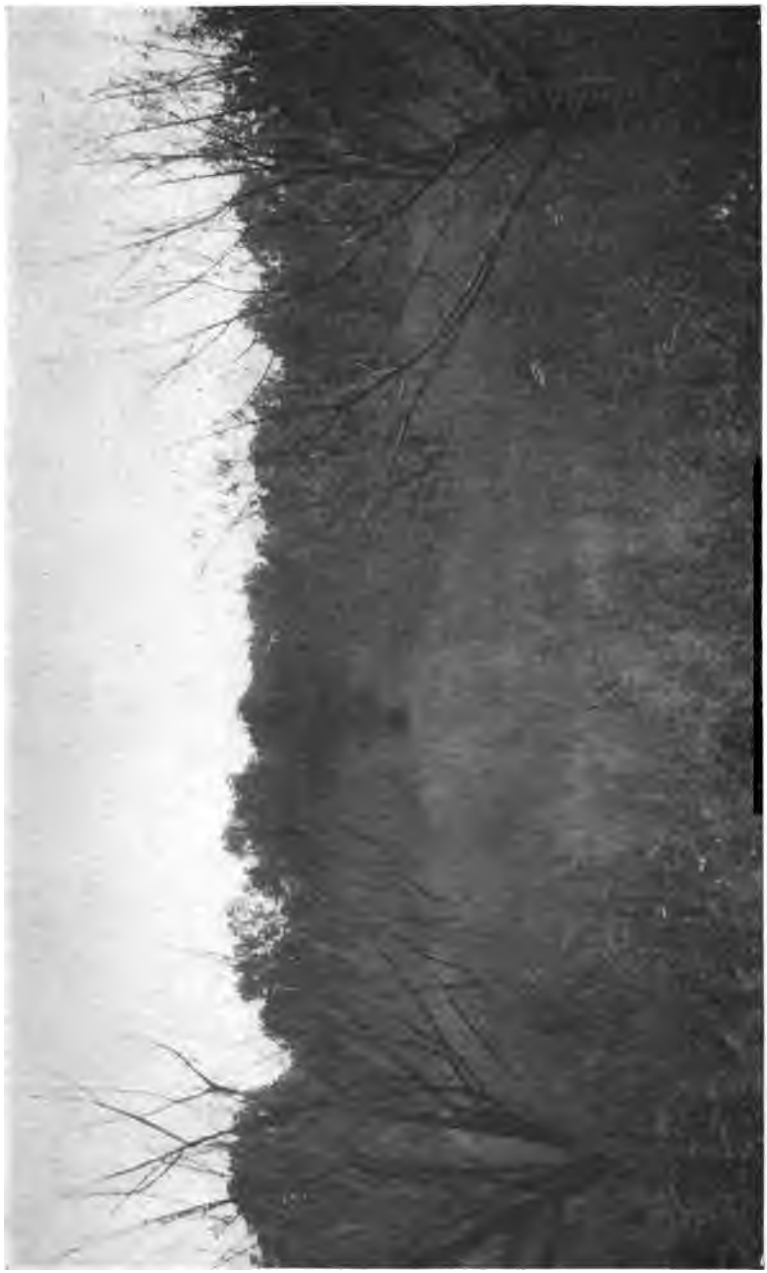
Under this heading will be discussed the various fungous and bacterial diseases of the peach trees and also the disease known as the Peach Yellows, which is not strictly a bacterial disease but which can not properly come under any other heading than the above.

DISEASES AFFECTING THE TREE.

Peach Yellows.—After twenty years of scientific investigation, the disease known as Peach Yellows remains today practically as much of an enigma as it was two decades ago. We are able to recognize the symptoms of the disease with more or less accuracy and we know that trees which are attacked never recover, and that the only means of preventing the further spread of the trouble is to cut out and burn all of the infested trees.

While the disease is known to be infectious, it has never been demonstrated that it was caused by any specific organisms. It is liable to attack the tree at practically any age from the young trees in the nursery rows to old trees in bearing orchards. This disease probably had more influence in discouraging the peach

A TYPICAL CASE OF PEACH YELLOWS.



ORCHARD KILLED BY YELLOWS.

growers in southern Indiana fifteen and twenty years ago than any other trouble that they had to combat. The recognized the disease as positively fatal and had absolutely no means then for combating it.

PEACH YELLOWS.

The first effect of the disease is to cause a marked discoloration of the leaves. In bearing trees the fruit ripens prematurely and is characterized by bright red streaks running from the skin to the

center of the fruit. When the peach is cut, these streaks appear as lines and dots of bright red through the flesh of the fruit. Sometimes the peaches on infected trees will hang on the trees during the winter in much the same fashion that the mummies from the brown rot hang on the trees. About the third year after the tree is attacked it starts to die and low on the trunk will be developed great bunches of wiry, slender twigs. This condition is well illustrated in the accompanying photograph.

Whenever the disease is known to be present in an orchard, all suspicious trees should be taken out and burned at once. It is not advisable to carry the trees out of the orchard to burn them, but they should be cut up and burned where they stood so as not to carry the infection to any other portion of the orchard. Orchards that are well cultivated and where the trees are kept in a strong, vigorous condition are much less liable to be attacked by Peach Yellows than are those which are neglected, not cultivated and allowed to overbear without fertilization of the soil.

Like other diseases, Peach Yellows is more liable to attack a weakened tree than it is one which is in a condition of perfect health. This is simply another one of the innumerable reasons for giving the orchard thorough cultivation from the time that it is planted.

It has been supposed, too, that the Peach Yellows can be disseminated on nursery stock. The disease is rarely ever present on nursery stock in a condition that can be accurately diagnosed, so that the ordinary nursery inspection will not prevent the dissemination of the diseased trees. In general, we have been making an effort to prevent the sale of peach trees grown in districts that are known to be infested with the Peach Yellows. During the past years, several thousand acres have been inspected in Indiana and a large number of trees have been condemned and cut and burned by the owners. In one section in Morgan County this inspection work has resulted in a renewed enthusiasm among the peach growers and many new orchards are being planted.

BLIGHT—(Coryneum Beijerinck).

This is a fungous disease which affects the twigs and is readily recognized by the formation of gum on the infested branches. The fruit buds are also attacked by the fungus and usually killed. The leaves are frequently retarded and the tree is placed in a much weakened condition. The gum will be found to exude from the

EFFECTS OF PEACH BLIGHT.

dead bud in the twig and in general the appearance is somewhat like that produced by the work of the Fruit Tree Bark Beetle. By cutting into the branch, the tissue will be found to be discolored and in various stages of disorganization. The difference between this condition and the work of the Fruit Tree Bark Beetle can be readily recognized.

While the disease occurs in Indiana and I have observed it in a number of different localities I have never had any occasion to spray for the prevention of it. In fact, the trouble has been studied for so short a time that but little experimental work along the line of spraying has been attempted. In other States, I understand that winter spraying with a lime-sulphur solution or with a strong Bordeaux gives very excellent results. The winter treatment for the San Jose scale would, therefore, serve the double purpose of controlling the scale and also preventing the peach blight.

CROWN GALL—(Pseudomonas tumefaciens).

The Crown Gall on the peach is identical with the same disease occurring on the apple. In fact, it is now supposed that the various root galls on the different species of plants are all attributable to the same bacteria. Infestation usually takes place in the nursery, and infected trees have well developed galls on the roots usually near the surface of the ground when they come from the nursery.

The remedy for the entire trouble lies largely with the planter —simply not to plant trees that show injury of this sort.

This disease is one of the pests that it is almost impossible to locate in the work of inspecting nurseries, since it occurs usually below the soil line. No reputable nursery, however, will send out stock that is infested with this or any other disease, and when an order for trees is given the buyer should make it plain that he will pay only for stock that proves to be absolutely healthy in every respect.

PEACH MILDEW—(Sphaerotheca pannosa).

This fungous disease is not one to give the peach grower any concern owing to the fact that it does not attack our commercial sorts to any extent. The disease is more common on the trees in the nursery rows than in the orchards, but the self-boiled lime and sulphur will entirely prevent it.

The disease attacks the leaves and is noticed as a white web growing on the surface. Defoliation usually follows a severe at-

tack of the disease. The variety known as the "Friday" peach is especially liable to attacks of this fungus. This is an inferior seedling of no commercial importance, so that its susceptibility to the disease need give us no concern.

The mildew is the same as the fungus so common on the rose, where it often does great damage.

THE DISEASES AFFECTING THE FRUIT OR LEAF.

BROWN ROT—(Sclerotinia fructigena).

This is the most common disease of the fruit of the peach. It is known in various sections under different names, such as Brown Rot, Peach Rot, Common Rot and Monilia. It is of very wide distribution and occurs in all peach growing sections. As a rule, the disease is worse in wet seasons than in dry. Heavy crops also tend

BROWN ROT.

to favor the development of the disease and thinning is advisable not only from the standpoint of preventing the disease, but also from the standpoint of the general condition of the orchard.

Ordinarily, the rot attacks the peach after the time when it is half grown, starting as a brown area and ultimately involving the entire fruit. As the disease progresses the fruit becomes watery and finally shrinks and dries to a mummy, which hangs on the

tree over winter. These mummies which remain on the trees are the source of infection for the next season, and it is necessary to remove them carefully in the early winter and destroy them by burning, or by burying them deeply. In case these mummies are not removed from the trees, the disease may attack the blossoms early in the spring and destroy them. This phase of the disease is not well recognized by many peach growers and frequently the loss of a crop is attributed to frost when, as a matter of fact,

EFFECTS OF BROWN ROT.
Peaches dry up and hang on trees.

it is due simply to the neglect of the brown rot. In this case, the twigs may also be involved and killed. These may be prevented by removing the mummies in the winter as suggested, and if this practice could be followed out over a large area a great deal of good could be accomplished. Unfortunately, it is not possible to carry out such a measure with any degree of uniformity in an area of any size. There will always be some growers who will fail to look after their trees and there will always be enough neglected trees to furnish an abundant supply of spores to reinfect the well-cared for orchards.

Consequently, it will be necessary to adopt some spraying measures to prevent the occurrence of the trouble on the fruit. In the spray schedule given elsewhere in this report, there will be found recommendation for what is known as the fourth spraying applied about the time when the fruit begins to color. This spraying will have a great deal to do with the prevention of the rot on the fruit.

Some varieties are more susceptible to this disease than are others, and this fact has been recognized in the selection of the sorts recommended for commercial orchards and published elsewhere in this report.

PEACH SCAB—(Cladosporium carpophilum).

This fungous disease is widely distributed and occurs in practically all sections where peaches are grown. It affects the fruit, the twigs and the leaves. The effect on the fruit is superficial, the disease producing small, round spots of very dark grey or black. Ultimately, the entire fruit may become involved with this dark, grey, scabby condition and in badly affected specimens the fruit

PEACH SCAB

cracks open. The disease is more common on white peaches than on yellow peaches. I have found some growers who have had the peach scab in their orchards for many years and protested that it was not a fungous disease at all, but simply "the nature of the peach" as they expressed it.

I remember visiting one orchard where the peaches of a certain variety were all very badly scabbed and when I called the grower's attention to the fact he showed some surprise at my ignorance, as he thought, of that variety. "Why," he said, "that's the nature of the peach, to have those black spots on it. That's no disease." I had to talk to him for some time before I could convince him that he had one of the most serious peach diseases to contend with and that he could prevent all of it by thorough spraying.

When the disease attacks the leaf, the affected areas fall out and give the trees the appearance of having been shot at with a shotgun. The disease can be prevented absolutely by spraying with the self-boiled lime and sulphur solution as indicated in the spraying schedule published elsewhere in this volume.

PEACH LEAF CURL—(Exoascus deformans).

This disease of the peach is known in all parts of the world where peaches are grown. The spores are left on the twigs during the winter and infect the young leaves as soon as they open. The leaves are malformed by the growth of the fungous disease and are often highly colored. Ultimately, the affected leaves fall and a second crop of leaves may develop. As a rule, the second crop of leaves is free from the disease but it frequently comes out too late to be of any value in saving the crop of fruit, which falls through lack of nutrition soon after the first crop of leaves fall from the trees.

Seedling peaches are especially susceptible to the disease. It can be completely prevented by spraying with the lime-sulphur solution before the buds open.

NORMAL PEACH FOLIAGE.

PEACH LEAF CURL.

[5—28403]

PEACH LEAF CURL

INSECTS INJURIOUS TO SHADE TREES.

We have received so many requests for information regarding insects injurious to shade trees that I have decided to devote a portion of this report to this matter.

Before discussing in detail the various forms injurious to shade trees I feel that it is proper to say something about certain predisposing influences that have a great deal to do with the nature and severity of insect attack.

Trees in cities are notoriously more liable to insect injury than trees of the same sort planted in the open country. Writers in the past have attempted to lay this difference to the fact that our native insect-eating birds were more numerous in the country than in towns. While this is true beyond question, I feel that certain other influences should not be overlooked.

The soil and atmospheric conditions in our cities are entirely different from the country and as a result the city trees never possess the same vigor that characterizes the trees of the country. In most cases the moisture level in large towns has been lowered, often several feet, by the building of sewers and the covering of the surface with buildings and pavements. The smoke of factories is no small item in the changed city conditions which the tree must endure. The gases of combustion if not actually poisonous at least serve to clog the breathing organs of the tree almost to the point of suffocation. Added to these conditions, city trees have the infliction of the professional tree trimmer, who alone is sufficient excuse to discourage any but the most stout hearted. Many trees planted along the curb are injured by horses hitched to or near them—this is, however, a form of damage on which the city has no monopoly.

All of these conditions combine to render the city trees not only more subject to insects and disease but in some cases to actually cause their death without further assistance. During the past few years the maples in Indianapolis have been giving trouble each summer by shedding their leaves prematurely and by a peculiar withering and drying of the leaves. Most careful examination has shown that there is no insect or fungous parasite at work, and we have been forced to the conclusion that the condition is one brought about by the change in the moisture content of the soil since the

trees were planted. Some of the property owners protested that lack of water could not be the cause of injury on their trees because they watered them frequently. A little questioning generally brought out the fact that the watering consisted of a daily sprinkle of the surface—which really did more harm than good because it allowed of

TREES KILLED BY GAS IN INDIANAPOLIS.

the formation of a surface crust and permitted the escape of water by capillary action. If artificial watering is to be resorted to the trees should be dug around and the soil loosened to a depth of about a foot. *Plenty* of water should be used. A tree six inches in diameter should have the soil loosened around it for a distance of six feet in all directions. The roots are not immediately under

the trunk but often extend farther than the spread of the branches. A tree of this size could receive several barrels of water at one time without harm. After the water has soaked in keep the surface

A FORM OF INJURY FOR WHICH THERE IS NO EXCUSE.

soil loose—do not allow a crust to form. This is the same principle employed in the cultivation of corn—an operation designed to keep the moisture in the soil where the plant can use it.

Few people realize how much effect sewers have on the moisture content of the soil in cities. I have seen a very striking illustration of the way in which sewers work in draining the soil in Indianap-

THESE TREES WERE KILLED BY PAINTING TAR ON THE TRUNKS.
The sprouts at the surface of the ground show that the trees were still vigorous when the treatment was applied.

olis. About a year ago the city built a large sewer in College avenue north of Fall Creek. During the dry weather of the past summer this sewer never ran less than twelve inches of clear water and there are not a dozen connections on it. Such a drain on the soil

moisture can not help having an ultimate effect on the growth of trees in the drained area.

The influence of the tree trimmer in increasing the susceptibility of a tree to insect attack is often of more importance than would appear at first glance. Many trees are so weakened by wanton butchery that they become an easy prey to the various

THE BARK HAS BEEN REMOVED FROM THE AREA KILLED BY PAINTING TAR ON THE TREE.

This was on the south side where the tar and oil remained liquid longer owing to the warmth of the sun.

borers that seldom attack vigorous trees. While this vandalistic form of injury is preventable it is surprising how many people continue to allow the tree butchers to ruin fine shade trees. The tree

EARLY STAGE OF BRACKET FUNGUS ON HACKBERRY.

butcher goes on P. T. Barnum's old assumption that "there is a sucker born every minute." The truth of this was well shown in Indianapolis last year when some itinerant "tree doctor" went about painting the trunks of shade trees with a "dope" containing tar.

According to the self-styled expert, the preparation was absorbed through the bark and then disseminated to all parts of the tree killing any "bugs" that might be present. When there was no evidence of any insect injury the tree doctor would suggest the use of the tar paint to "open up the pores of the bark and make the tree healthy." It seems almost too absurd to believe that in-

BRACKET FUNGUS ON HACKBERRY.

telligent citizens would be caught by such a faker, but even after a series of newspaper warnings he succeeded in painting hundreds of trees throughout the city The deplorable thing about it all is

RESULT OF BRACKET FUNGUS ON HACKBERRY.

that practically every tree that was painted died—and there appears to be no law to cover the case

The fact that insect-eating birds are less plentiful in cities is true, but I believe that the conditions are rapidly improving. Intelligent nature study has done much to lessen the ardor of the

small boy who formerly used his sling shot and airgun to such harmful advantage. I am not in favor of any system of training that will make "sissies" out of our rising generation, we will always have enough of them anyhow, but I feel certain that our young boys will make stronger, better men if they are taught some of the simple though vastly important facts of nature.

It is probable too that the English sparrow has done nearly as much as the small boy to make the life of song birds miserable in the cities. I doubt, however, if the sparrow is as black as he has been painted and I sadly fear that some published opinions of him have been biased by the writers' loss of early morning sleep. I know for a fact that the English sparrow is far more of an insect-eating bird than he has the credit of being. I have observed them extensively and bird for bird I know that the English sparrow is a more valuable species from an entomological standpoint than is out well beloved robin. Were it not for the joy the Red Breast brings when he comes to us with each returning spring, I think that we could do without him very nicely. He destroys few injurious insects, eats much fruit and literally gorges himself on our soil improving fishing worms.

One more influence against the presence of birds in cities should not go unmentioned. The peaceful (in day time) house cat is one of the worst enemies of birds we have. I never owned but one cat, but that one was the most persistent and successful hunter I ever knew, although she maintained about the house an air of innocence that would do credit to a saint. Considering the threefold objection to the cat of being a destroyer of birds, a harborer of

"* * * jumping cattle
In shoals and nations,"

and an active carrier of disease germs of all kinds, is it not about time that we banished this medieval pet from our modern civilization? I can hear at once the protest of a certain class of femininity and of a few others who sincerely believe in the cat as a destroyer of mice. This last argument is the only one that can be brought in favor of the feline member of our households and I have a five cent mouse trap that possesses more efficiency in its capacity than any dozen cats that ever lapped milk.

In spite of the boys and the cats and the English sparrows, we can induce many of our song birds to build near our homes if we will provide a few devices to attract them. A food supply, clean water, shelter of some trees and a few nesting boxes will work won-

ders in increasing the population of native birds. In spring, nest building material and boxes with various size holes will attract wrens, martins, blue birds and even tufted titmice and flickers;

CITY NURSERY AT INDIANAPOLIS SHOWING PIN OAKS INJURED BY FUNGOUS DISEASE THAT IS AS YET UNKNOWN.

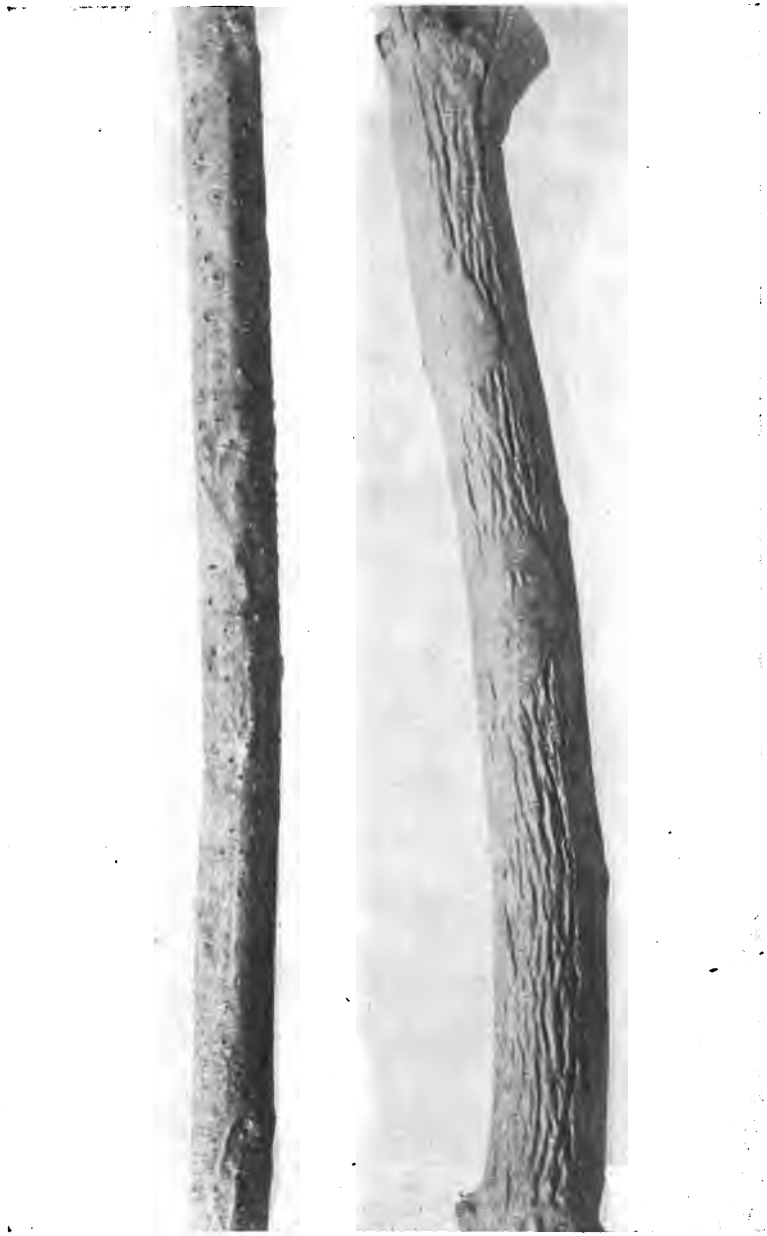
while in winter many downy woodpeckers, chickadees, nut hatches and brown creepers will be attracted by suet and fat meat nailed to a tree or post.

Let us teach the small boy to abandon the slaughter of song birds; banish the house cat to extermination and provide means to attract desirable birds to the cities. If this program could be

CITY NURSERY AT INDIANAPOLIS SHOWING HEALTHY PIN OAK TREES.
This nursery is one of the best kept in the State. It is managed in the interests of the city parks.

worked out—and it ultimately will be worked out—we would see a marked return of insect-eating birds to our city trees.

There remains for consideration only the influence of the city



THE CHESTNUT BARK DISEASE.

atmosphere in inducing insect injury to shade trees. The smoke laden air of our large towns has long been recognized as a baneful influence to the growth of trees, simply because the leaves are soon varnished over by a coat of soot. The leaves are the breathing organs of the tree and as soon as the pores through which the exchange of gases takes place, become clogged, the entire tree must suffer. In spite of smoke commissions and municipal orders it seems likely that our larger cities will continue as active producers of the dense black, and if we are to have trees in the smoky parts of town we will either have to let them take their chances or else plant varieties that have shown themselves to be smoke resistant. There are comparatively few that have good records in this direction and these few are not our most desirable trees in other respects, but they will grow where nothing else will. Chief of these trees is the despised and maligned Ailanthus which is destined to be one of our main street trees of the future. More will be said on this point later on in the discussion of individual trees.

FEW TREES WILL STAND FOR THIS KIND OF TREATMENT.
The one shown is a beech and died the first season after the walk was put down.

LIST OF TREES.

The following list of shade trees has been prepared as a guide for city planting. The list is followed by a table giving a brief review of the standing of the different trees from an entomological and city resistance standpoint.

AILANTHUS.

The Ailanthus is one of the most resistant trees that we have for planting along our city streets. It is also one of the quickest

AILANTHUS TREES.

growing shade trees that we have and will produce shade in less time than any other species which can be planted. The leaves are large, compound and are extremely ornamental. The trees will grow in almost any situation and seem to delight in growing in the crowded places. We often find them at their best in the densely

THE AILANTHUS TAKES ROOT IN CROWDED PLACES.

populated portions of the town where the seeds have found lodgement close to a building and have only a few inches of space in which to grow.

There are only two arguments against the Ailanthus as a street tree and these are the facts, that it is short lived and during the flowering season it gives off an exceedingly bad odor. The leaves

also possess a bad odor when they are crushed. The Ailanthus has no insect enemies and is practically never attacked by any fungous

AILANTHUS ON RESIDENCE STREET.
(An nsect resistant form.)

parasite. No other tree would do so well in the down town districts in cities and sooner or later the trees must be planted in such locations if we are to have any shade at all in such places.

WHITE ASH.

The White Ash is a beautiful native forest tree with exceedingly graceful branches and compound leaves. The foliage is quite thin and even during the summer, the outlines of the larger branches can be traced throughout the tree making it desirable for locations where dense shade is not desired. The tree is very rapid in growth and is hardy and long lived.

THE WHITE ASH IS A RAPIDLY GROWING TREE.
The one in the picture was ten feet high after two seasons growth from the seed.

It is not quite so well adapted to city conditions as the Ailanthus but it does far better than the majority of trees in the down town districts. It is seldom subject to insect injury, although sometimes the trees are attacked by boring beetles. It is almost equally free from fungous diseases and it is a tree which can be heartily recommended for planting along our city streets.

BUCKEYE.

This native tree is a rapid grower and is an exceedingly handsome species, especially in the spring of the year when the mature trees are literally covered with clusters of pale, yellowish-white flowers.

The trees, however, are quite subject to insect injury and are sometimes attacked by a fungous disease which causes an early

defoliation. The trees are not resistant to city conditions and altogether it is not a desirable one to plant. The trees are especially subject to the attacks of the red spider, the Tussock Moth, the Lace Bug and the Putnam Scale.

CATALPA TREES ALONG CITY STREETS.
A desirable tree because of its low habit of growth.

CATALPA.

The Catalpa is a rapidly growing and picturesque tree, rather well adapted to city conditions. Throughout Indiana, however, the Catalpa is subject to several insect and fungous enemies which

make it a tree of doubtful value for planting. The Catalpa Sphinx Moth has caused the defoliation of Catalpa trees in large numbers throughout Indiana and the Catalpa Blight has killed many fine shade trees.

There are three species of Catalpa offered ordinarily by nurserymen. Namely, the Catalpa Speciosa, Catalpa Bignonioides and Catalpa Kempferri. It is almost impossible to distinguish between the first two species named until after the trees come to considerable size. Consequently, it is not advisable to trust the opinion of the nurseryman regarding the kind of tree which he has to offer. I have bought Catalpa trees from presumably reliable nurserymen with the assurance that they were absolutely pure Catalpa Speciosa and I have developed from these young trees not only Catalpa Bignonioides but in some cases Catalpa Kempferri as well. The Kempferri is a Japanese species and in some respects seems to be more hardy than the native varieties. It is to be distinguished by the fact that the leaves are somewhat sharply lobed and the seed pods are exceedingly small in diameter and are borne in large clusters.

Where the owner is prepared to spray the trees and give them the best of care, the Catalpa can be planted with assurance of success. It is almost certain, however, to require this attention sooner or later in its life. Personally, I prefer the Catalpa Bignonioides for street planting, owing to the fact that the trees are not as symmetrical and uniform as are the trees of the Catalpa Speciosa. The majority of all trees offered by nurserymen are of this species so that the planter is reasonably sure of securing the Catalpa Bignonioides whether he really wants it or not.

CHESTNUT.

While the Chestnut is exceedingly resistant to insect injuries, it is not a desirable tree to plant along crowded city streets. On the streets in the outer districts where there is more room and better air, the chestnut will make a desirable tree. Like the Oak it must have plenty of root room and a good atmosphere in which to develop its greatest possibilities.

In some sections of the east, chestnut bark disease has destroyed thousands of trees; in fact in some States, this disease threatens to exterminate this tree. The Government is now at work in an effort to destroy all trees infested with the chestnut bark disease and it may be that the trouble will be stamped out before it

reaches our western districts. There are one or two other diseases of the chestnut which sometimes destroy the tree. For this reason, its resistance to fungous injury has been placed somewhat lower than it would ordinarily be, although in some districts the tree is perfectly hardy and the diseases mentioned do not occur.

COFFEE TREE.
A good tree for open planting.

KENTUCKY COFFEE TREE.

The Coffee tree is exceedingly resistant to insect injuries. I know of very few insects which do any damage to the tree and of none that does any important damage. It is also exceedingly resistant to fungous injury. I have never seen the tree tried in the crowded districts of a city, but from the fact that it is one of our native forest trees I am afraid that we can not expect much from it under the adverse conditions of city life. For the outer districts where the soil condition and atmosphere are better, it is an excellent tree to plant.

THE ELM.

Of all of the trees that are planted for shade in the cities, the elms are most liable to be injured by insects. Both European and American elms have a host of enemies, many of which are difficult to control and some of which prefer the elm to any other food plant. The Elm Tree Borer, the Scurfy Scale of the elm, the Spiny Elm Caterpillar and the Elm Leaf Beetle are insects which prey on this tree, almost to the exclusion of any other. In addition, the tree is often injured by the Woolly Louse of the elm, by another Spiny Caterpillar, by the Tussock Moth, Bag Worm Moth and frequently by the Cottony Maple Scale. There are many other trees that are, to my mind, the equal of the elm in beauty that could very easily be planted in preference to the elm in our parks and cities.

Any one who plants the elm trees must be prepared to spend large sums of money in protecting these trees later on in their growth. I understand that one of the large colleges of the east spent an average of $18 per year per tree to protect the elm trees which stand on the college grounds. These, of course, are large trees, but it will give some idea of the extent of the insect injury and the cost of its prevention. The elm is somewhat resistant to fungous injury and maintains itself in cities fairly well. The only drawback to it is the extreme liability to insect injury. This injury is so great that it will not pay the cautious planter to attempt to grow elm trees in our present day condition.

The European elm is an introduced form which lacks much of the beauty of the American elm and is somewhat more subject to insect injuries than the native form.

THE GINKO.

This Asiatic deciduous Conifer has shown itself to be one of the best trees that we can plant along our city streets. The trees are quite symmetrical and like most of the other Conifers grow tall and more or less cone shaped. The fact that the leaves are shed in the fall of the year eliminates this tree from the objections urged against the native evergreen Conifers in that the leaves escape the injury of the extreme smoke of the winter. The tree is of a fairly rapid growth but presents a somewhat straggly appearance until it is several years old. Even at its best, the Ginko would probably be considered more of an oddity than a tree of beauty, for it lacks much of the grace of our native trees. It is hardy, resistant to both insect and fungous injuries and withstands our city conditions. I should recommend the tree for rather general planting in our large towns.

HORSE-CHESTNUT.

While the Horse-Chestnut is a rapidly growing and rather beautiful tree, it is quite subject to insect injuries and is frequently injured by the attacks of various fungi. It does not stand the dry soil conditions of our cities as some trees do and is recommended only for planting in the wider streets in the outer districts of the town.

The tree is especially subject to the attacks of the Tussock Moth, which frequently result in the complete defoliation of the tree. The Putnam Scale is another pest which is sometimes destructive to this tree and on a few occasions the common lace bugs have done considerable damage.

It is another one of our shade trees which is frequently badly injured by the attack of the red spider. This pest usually occurs in injurious numbers only in dry seasons, when its injury can be prevented by a liberal use of water, not only around the tree but on the leaves and branches as well.

HICKORY.

While the various hickories are desirable for planting in parks and along streets where they will have plenty of room, they are not well adapted to city conditions. Where they are grown it is well to plant the nut where the trees are to remain, as the young trees do not stand transplanting well.

HACKBERRY.

The Hackberry is one of the trees that has given very excellent results on some of the crowded city streets. It is quite resistant to various insect injuries and is not often attacked by any fungous disease of any importance.

Several years ago, the Hackberry trees in the Indianapolis parks were attacked by an epidemic of a certain bracket fungus. Specimens of this fungus were sent to Wabash College and to Cornell, but no positive identification of the species was made at either place. This fungus attacks the tree on the trunk usually about two or three feet from the ground and appears to destroy the tissues above and below the point of attack. The large brackets appeared in early summer and remained on the tree indefinitely. An examination made last summer showed that the dry weather of this season had prevented the development of the fungus to any serious extent. No brackets were found to be present on the trees that had been badly infested. On some trees the work of the fungus would be very easily observed by the successive layers of dead bark extending out from a common point of infection. The condition is well illustrated in the accompanying photograph.

In case this disease should attack the tree, the proper method to employ would be to cut out all of the diseased tissue and paint the cleaned wound with a solution of corrosive sublimate in strength about 1 to 1,000. When this solution is dry the wound can then be painted over with pine tar and if the cavity is deep enough it can be filled with cement. As a rule, however, the injury of this fungus is superficial and there will be nothing left to fill with cement.

The hackberry is quite resistant to the moisture and atmospheric conditions of the city, although in dry seasons the tree is sometimes defoliated by the red spider. It is probable that this pest is worse on the hackberry than on any other tree. As I have observed the work of this mite only in the city of Indianapolis, I hesitate to condemn the hackberry for city planting on that account. Consequently, in the table of Comparative Immunity I have rated the hackberry somewhat above other trees in resistance to insect attacks.

LINDEN.

I wish that the Linden tree did not have so many insect enemies, for I would certainly like to be able to recommend it for planting along our city streets The tree is not only beautiful,

hardy and of rapid growth, but it is one of the few trees which yield a large quantity of nectar for the honey bees to use for the manufacture of honey.

It is subject to so many insect pests, however, that I doubt whether it would be wise to recommend it for planting under the adverse conditions of our city streets. The Tussock Moth and Bag Worm Moth annually defoliate many trees of this species in our large cities and so stunt their growth that they never make a perfect specimen, as they otherwise would. In addition to these two leaf-eaters, San Jose Scale, Cottony Maple Scale, the English Walnut Scale and the Putnam Scale are all commonly found on this species of tree.

Occasionally, the trees are defoliated by the attack of a leaf spot fungus. When the Linden can be grown in the open country, where it will have plenty of soil moisture and clear atmosphere in which to grow, it is an admirable tree to plant. I would recommend it for many situations, but not for city streets.

BLACK LOCUST.

The Black Locust is one of the trees not native to this section, but which came here with the earliest settlers. We find many old Black Locust trees growing around the homesteads which were established by the early pioneers, and as a rule around the homesteads which were established by those pioneers who came to this country from western Pennsylvania, where the Black Locust is a native. This tree has also entered Indiana by way of the Ohio River, the seeds having been brought down by the floods in that stream.

The tree has one serious insect pest which is so universally distributed and so severe in its injury that it makes the tree undesirable for planting purposes.

HONEY LOCUST.

This graceful, hardy tree should be more widely planted not only in our city streets but throughout the country as well. This is one of the most beautiful native trees that we have and is quite resistant to both insect and fungous enemies and further withstands the adverse conditions of our city streets exceedingly well.

In dry seasons, the Honey Locust is sometimes injured by the attacks of the red spider, although this injury is seldom sufficient to cause any damage to the tree. The fact that the tree is covered

with formidable thorns makes it an exceedingly desirable nesting place for birds. In its branches they are fully protected from the predatory house cat.

MAPLES.

NORWAY MAPLE.

Of all of our maples, it is probable that the Norway is the best adapted for planting along the city streets. It is quite resistant to insect injuries and is seldom, if ever, attacked by any fungous disease. It also seems to be able to withstand the dry soil conditions of the city, although within recent years the Norway has shown some injury of this sort in Indianapolis. In such cases the leaves wilt in midsummer and frequently will fall to the ground in large numbers.

My chief objection to the Norway Maple is the fact it is not a native tree and I do not like its habit of growth. When you have seen one Norway Maple you have seen all of them. They are absolutely uniform in their development and have but one redeeming feature in their appearance. This is during the time when they are in blossom. A row of Norway Maples in full bloom is certainly a gorgeous sight, for the clear light yellow of the blossoms makes each tree a perfect mound of color.

SUGAR MAPLE.

The Sugar Maple is quite resistant to fungous and insect enemies, but it is not adapted for planting along our city streets. The trees must have an abundant supply of moisture if they are to succeed. Several years ago, the federal authorities planted Norway Maple trees around the post-office building at Indianapolis. They were planted in a narrow strip of soil lying between the curb and the sidewalk. This, with the exception of a small grass plot in front of the building was the only exposed soil for several hundred yards in any direction from the trees. Had any intelligent landscape architect been consulted, he could have told the authorities at once that the trees could not possibly grow in that situation. The trees were, apparently, planted blindly, and as a result they all died the first season.

This planting was followed with another planting of Sugar Maples which are even harder to grow than are the Norways. The hard maples died even in shorter time than did the Norways, as could have been predicted by any one familiar with the tree. These trees have been replaced from time to time until today there

is a straggling row of half dead trees extending around the federal building. None of them are any larger than they were the day that they were planted and it is safe to say that none of them ever will be any larger.

There are two criticisms to be made on a planting of this sort. In the first place, the trees that were selected were not adapted to the soil conditions that they had to endure. In the second place, the location selected for the trees is not one in which trees should be planted at all. The federal building is a magnificent piece of architecture and it would be a mistake to plant a row of large trees around such a building. Good taste and a general sense of the fitness of things should suggest that a building of this sort would look better if it is allowed to occupy a large space without the detracting influence of trees around it. The place where the trees were planted could very well have been used to plant small growing shrubs or it would have been fully as effective to keep the narrow plat between the sidewalk and the curb in fresh green sod.

SOFT MAPLE.

The Soft Maple is an exceedingly rapid growing tree and one that has been extensively planted along the city streets in the past. So extensively in fact, that we have abundant data on which to condemn it as a city tree. Few trees have more insect enemies and they are frequently attacked by fungous diseases of considerable importance. The tree is more resistant to the soil conditions of the city than is the native hard maple, although not quite so resistant as the Norway. Its susceptibility to insect attacks, its danger from fungous diseases and the fact that it is short lived makes it an undesirable tree for city planting.

RED MAPLE.

It is a surprising fact that the Red Maple which in a state of nature prefers to stand with its feet in water makes a quite successful tree for city planting. It is resistant to insect and fungous enemies and is far preferable for street planting than the native soft maple. It is almost as rapid growing a tree as the soft maple.

PIN OAK—RED OAK.

These two oaks are well adapted for planting along the streets where they will not be too crowded and where the atmosphere of the city is not too dense. They are both quite resistant to insect enemies and have very few fungous diseases. Last summer we

found a fungous disease attacking the Pin Oaks in the city nurseries at Riverside Park, but so far the study of the disease has not progressed far enough to make a definite statement regarding it at this time.

Contrary to general supposition, these two oaks are not of slow growth, the Pin Oak being quite a rapid grower and the Red Oak being almost as fast.

PINE.

WHITE, SCOTCH AND AUSTRIAN.

These are the three principal species of pine planted for shade and ornamental purposes, in our cities. Like all other evergreens they are unsuited to city conditions owing to the fact that the leaves remain on the tree throughout the winter and become so clogged with smoke and soot in the winter time that the tree suffers materially. Where the trees can have plenty of room and good atmospheric conditions of the country, the white pine will probably make the most successful tree, although the Scotch and Austrian pines are both excellent. Personally, I prefer the white pine because it is a more rapid grower and because it is a native American tree.

These trees have but one important insect pest in our locality and this is the pine scale, which is mentioned elsewhere in this report.

SPRUCE.

NORWAY SPRUCE.

Were it not for the fact that the Norway Spruce is an evergreen and subject to the general objection against evergreens, this would make an admirable tree for planting on our city streets. It is an excellent tree for small towns or for the country, where it can have a reasonably clean atmosphere in which to develop. It is sometimes attacked by the pine scale, but this is of rare occurrence, the Norway Spruce being one of the least injured of all our Conifers.

The Colorado Blue Spruce is a different species, a native of Colorado and possessed of more or less bluish tint.

Koster's Blue Spruce is a horticultural variety of the Colorado Blue and is of a more pronounced blue color than is the Colorado form. Neither of them seems to thrive quite as well as the Norway Spruce, although occasionally we see fine specimens.

SYCAMORE.

The native Sycamore is ordinarily a tree of the water courses and yet we find that it is able to resist the dry soil conditions of our city streets almost as well as any tree that we have. Syca-

THE SYCAMORE THRIVES EVEN IN THE DRY SOIL OF CITIES.

EFFECT OF FUNGOUS DISEASE ON SYCAMORE TREES AT HOBBS' NURSERY.

mores are also comparatively free from insect injury and it is seldom that we find any serious insect depredations present on the leaves or trunk.

SYCAMORE TREES KILLED BY FUNGOUS DISEASE.

In recent years an important fungous disease has made its appearance and thousands of sycamores have been destroyed by it. For this reason the rating of the sycamore in regard to its susceptibility to fungous disease is necessarily low. I still regard it as a desirable tree to plant along the city streets.

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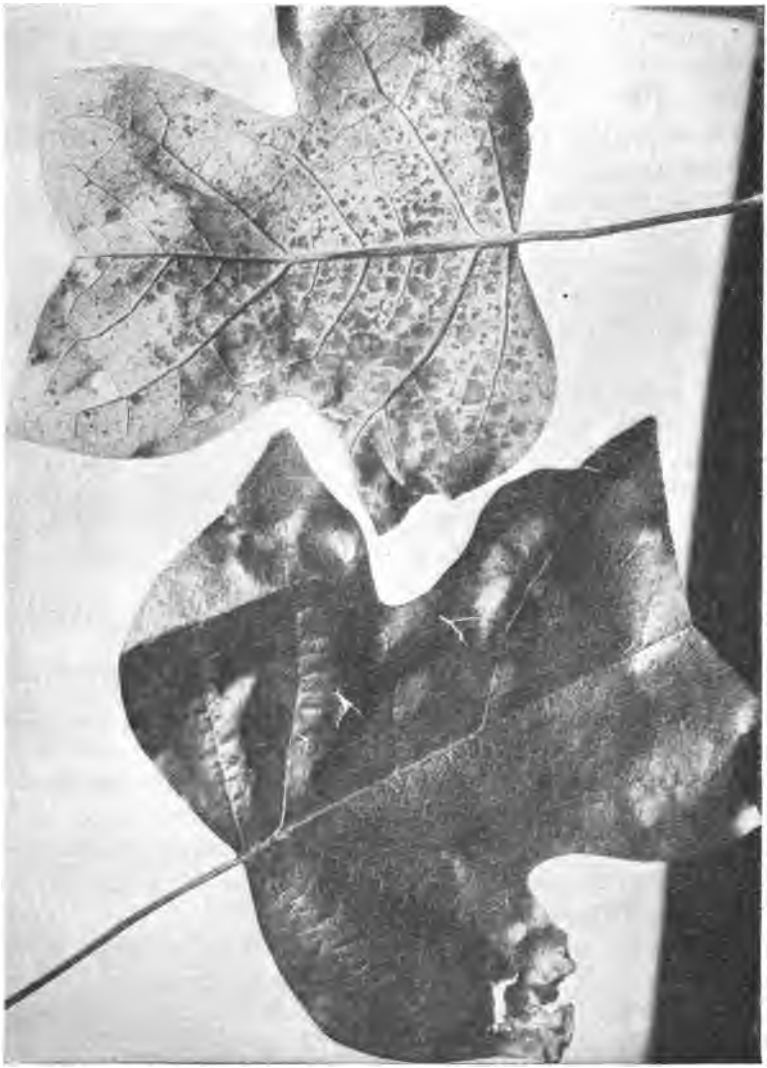
SYCAMORE IN A CITY PARK.



LEAVES OF TULIP TREE SHOWING NORMAL CONDITION AND EFFECTS OF LEAF SPOT.

TULIP TREE.

With very few exceptions the Tulip tree, or Yellow Poplar of commerce, is one of the very best to plant along our city streets. It is not to be confused with our Carolina Poplar for, in fact, the tree is not a poplar at all but is a member of the Magnolia family. It is rapid growing and makes a beautiful tree that is strong and long lived; exceedingly free from insect injuries and nearly as free from the possibility of fungous injury.

Great care must be used in planting the tree, as they do not stand transplanting well. The chief mistake that is made in this particular is in attempting to plant too large a tree. A small tree, two or three feet high, will become established quickly and in the course of ten years will have a great advantage over a tree eight or ten feet high and several inches in diameter which was planted at the same time.

Two of the handsomest Tulip trees that I have ever seen for their age were growing in the yard of Mr. C. J. Pickering of Middletown. At the time I saw the trees that were thirty feet in height. Mr. Pickering told me that when he planted the trees eleven years ago they consisted of two leaves each, being simply tiny seedlings that he had brought in from the woods.

BLACK WALNUT.

The Black Walnut is not adapted to our city street conditions, but makes an excellent shade tree on large lawns where the soil conditions are more nearly normal, or perhaps it would do well on the streets of small towns. The tree is very rapid in its growth and lives to a great age. It does not stand transplanting well and, like the hickories, the nuts should be planted where the trees are to remain.

Frequently the Walnut is defoliated by the Walnut Worm, but, as a rule, this defoliation comes late in the season and but little injury results to the tree. If the trees are carefully watched, the injury can be prevented almost entirely.

WEEPING WILLOW.

This is another tree of our water courses that has shown itself to be well adapted to planting along the city streets. Some of

the best trees in the down-town sections of Indianapolis are of this species. This tree is exceedingly resistant to fungous diseases but is somewhat subject to the attacks of leaf-eaters such as

THE WEEPING WILLOW IS A GOOD TREE FOR CITY CONDITIONS.

the Bag Worm Moth and the Tussock Moth. With these exceptions, the Weeping Willow can be recommended for planting in the crowded parts of our larger cities.

WILD CHERRY.

A native tree that is not recommended for shade tree planting.

TABLE INDICATING RELATIVE IMMUNITY FROM INSECT INJURY, FUNGOUS INJURY AND GENERAL RESISTANCE TO CITY CONDITIONS.

SPECIES.	Insect Injury.	Fungus Injury.	City Conditions.
Ailanthus	10	10	10
Ash, White	9.5	9.5	8.5
Buckeye	6	6	4
Catalpa	6	5	7
Chestnut	9	5–10	4
Coffee tree	9.5	8	4
Elm	3	8	7
Elm, European	2.5	8	7
Ginko	10	10	9
Hackberry	7	9	6
Hickory	6	9	4
Horse Chestnut	6	6	5
Linden	5	8	4
Locust, black	4	8	5
Locust, honey	7	9	7
Maple, Norway	7–9.5	10	7
Maple, Sugar	7	10	3
Maple, Soft	4	6	6
Maple, Red	8	8	7
Oak, Pin	8	10	6
Oak, Red	8	10	6
Pine, white	8	10	2
Pine, Scotch	8	10	2
Spruce, Norway	9.5	10	2
Sycamore	9.5	4	8
Tulip Tree	10	9	8
Walnut, Black	5–8	9	3
Willow, Weeping	6	10	9

INJURIOUS INSECTS.

A list of the more common insects injuring shade trees in Indiana including a few forms that are either present or are liable to be present in the next few years.

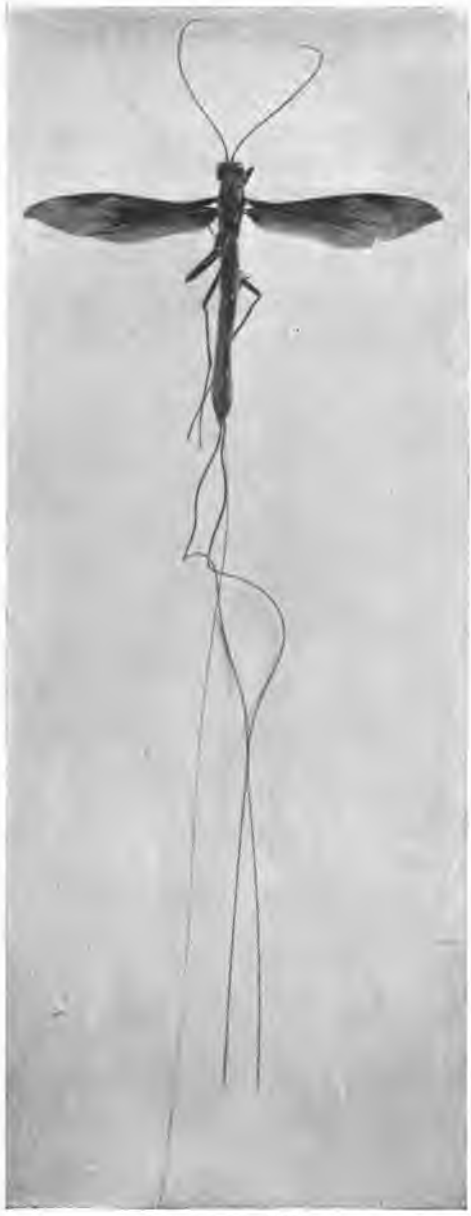
Boring Insects.

Pigeon Tremex (Tremex Columba). This common borer belongs to the hymenoptera and is one of the few members of this order which is injurious to our shade trees. The borers prefer to work in the maples, especially the native hard maple and, in some sections of the State, they have done a great deal of injury to the shade trees. This is notably true of some of the smaller towns in the northern part of the State. The eggs are laid in cracks in the bark, preferably in trees that have been weakened by some other agency. This fact holds true in regard to a great many of the boring insects; that is, they are more liable to attack trees that have been injured by some prior cause.

The young borers work in the body of the tree, and, frequently, may be present in the tree for a number of years before causing its death; differing from some of the other borers, in this respect, that do their work for the most part between the bark and the wood, thus girdling the tree.

The life cycle of the Pigeon Tremex is approximately twelve months. The adult female sometimes becomes fastened to the tree in the act of laying the eggs in the cracks of the bark, as the ovipositer becomes wedged in the bark tissues and holds the insect captive. One of the interesting things about this insect is the fact that it has a characteristic parasite in the Thalessa lunator. This parasitic insect is well illustrated in the accompanying photograph and no description is necessary.

One of the interesting points regarding this boring insect and its parasite is the fact that the parasites are much more often found than are the borers themselves. We frequently have people sending in specimens of the parasite and almost invariably they claim that the insect was caught in the act of boring holes in their maple trees. As a matter of fact, the long ovipositer of the Thalessa Fly is used to reach to the interior of the boring of the



THALESSA FLY.

pigeon tremex and to lay the eggs in that position. Probably a good many Thalessa flies are destroyed by people who are ignorant of their value. It is probable that this one parasite does more than anything else to keep down the numbers of the Pigeon Tremex and for this reason it is not a widespread pest in this State.

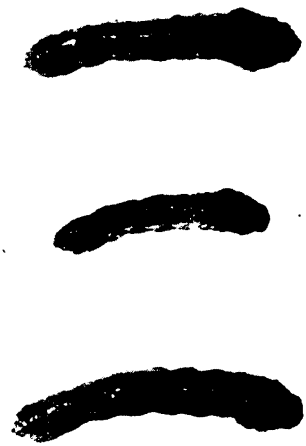
A TREE THAT IS BEING KILLED BY THE ELM BORER.

Wherever the insects are found to be injurious the borings should be carefully cut out with a sharp chisel and wherever the insects are found to be present they should be destroyed. It may be of value to inject a small quantity of carbon bisulphide into the borings of this pest and plug the mouth of the tunnel with putty or some similar substance. Where this work is carefully done and persisted in, the borers can be exterminated after one season's effort.

This method of treating borers is not practical except for those

forms which work in the central part of the tree. Borers which work between the wood and the bark are more difficult to reach, owing to the fact that their channels are very frequently plugged with sawdust, and are often so long and tortuous that the carbon bisulphide does not seem to be effective.

Elm Borer (Saperda Tridentata). This exceedingly injurious beetle affects all of our native elm trees to a greater or less extent. As a rule, the beetles prefer to attack trees that have been



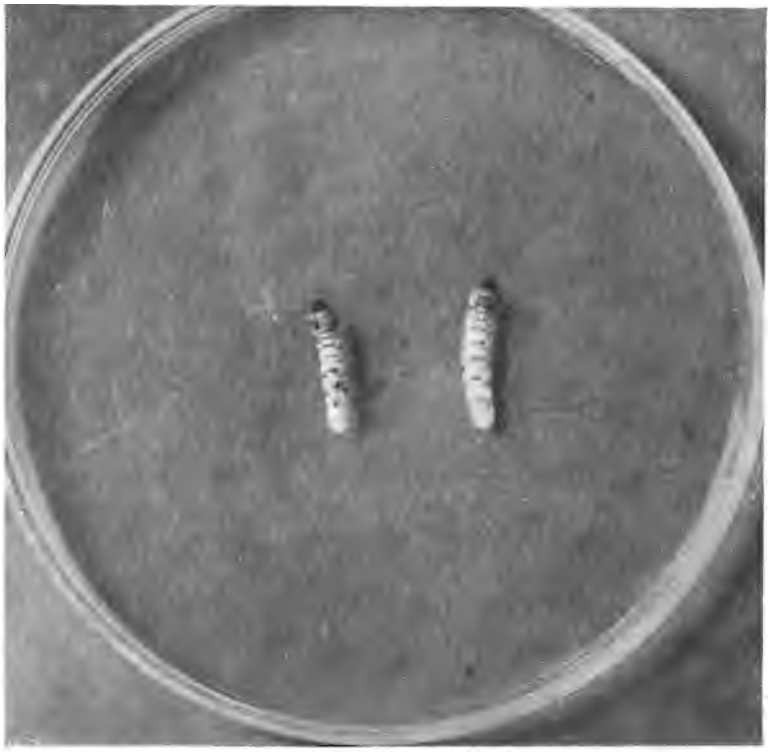
ELM BORERS.

weakened through some other cause and for this reason, we find that they are far more common in cities and towns than they are in the open country, although occasionally we find that the elm trees in the native woods are seriously injured.

The adult is a beetle about one-half inch long. The antennae is longer than the body. The body is marked with red. The larvae are characteristic flat-headed borers, that is, the head end of the grub is flattened, and not only the head but the segments immediately behind the head are flattened, giving the insect the characteristic hammer shape. The adult beetles appear in early summer and the eggs are laid from June till sometime in August.

The length of the life cycle is not known, because the life history of this form has never been completely worked out. The larva of various sizes can be found in the trees at the same time, so that it appears that the life cycle is probably more than one year.

Several years ago the insect became unusually bad in the city of Vincennes, and in the course of three or four years it destroyed



ELM BORERS.

practically every elm tree in the town. The insect is now at work in the northern part of Indianapolis and the adjacent country and it is probable that a large number of the elms in the city of Indianapolis will be destroyed within the next few years.

There is practically no remedy for the elm borers except to cut and burn all infested trees and in this way prevent the spread of the insects to other healthy trees. This remedy was suggested a number of years ago in the city of Vincennes, but it was not

WORK OF BORERS IN ELM

followed out as it should have been. Consequently, the borers took tree after tree until, today, there is practically not an elm left in the town.

Common Flat-Headed Borer (Chrysobothris femorata). The larva of this beetle is slender with a very much enlarged flat head, resembling in this respect the larvae of the elm borer. The adult is about one-half inch long, gray in color and the antennae are not as long as the body. The eggs are laid the last of May in crevices in the bark and the burrows that are made between the bark and the wood are flattened in cross section and are not cylindric as in the case of the Long Horned Borers. This beetle attacks many kinds of shade trees and, also, is sometimes found working on fruit trees. What has been said about the preceding forms applies to this insect as well. Like the other borers it is exceedingly difficult to control, and the best that can be done is to keep the trees in strong, healthy, vigorous condition, so that they will be in a condition to resist the attacks of the borer at the start. When they first attack a tree the borers are rather difficult to detect, and usually their presence is not discovered until considerable damage has been done. Where by any chance they can be discovered before any serious injury has taken place, they can be cut out and destroyed. There is practically nothing else that can be done to remedy their injury.

The Locust Borer (Cyllene robiniae). This handsome beetle is about three-fourths of an inch in length, black in color and marked with brilliant yellow. The adults emerge in the fall of the year, and lay their eggs on the bark of the Black Locust, confining their depredations almost exclusively to this tree. When the young larvae hatch, they immediately bore into the tree and work throughout the woody tissues. This borer is especially destructive to the young locust trees the first few years after they are planted. It has caused a great deal of injury to the plantings of black locust which have been made in various parts of the State by farmers who were attempting to grow their own fence posts. I know of many plantations of black locust that have been completely ruined by the work of this beetle. In fact, the injury is so serious and so certain that I do not recommend the planting of black locust save in a very few restricted areas where the insect does not appear to do any considerable damage. Over a large portion of the State the damage from the locust borer is almost as certain as death and taxes.

Many years ago the black locust was planted by some of the early settlers, especially the ones that came from western Penn-

sylvania, as a shade tree around some of the old homesteads. These old trees are being cut down in a great many instances, and it is very interesting to note that the locust borer was present at an exceedingly early date. Many of the old black locust trees that are two feet or more in diameter, at the present time, show that they were badly injured by the locust borers when they were a few inches in diameter. Evidently, the black locust is able to overcome the work of this beetle to a certain extent. If a tree can survive the first attack without dying to the ground or being blown

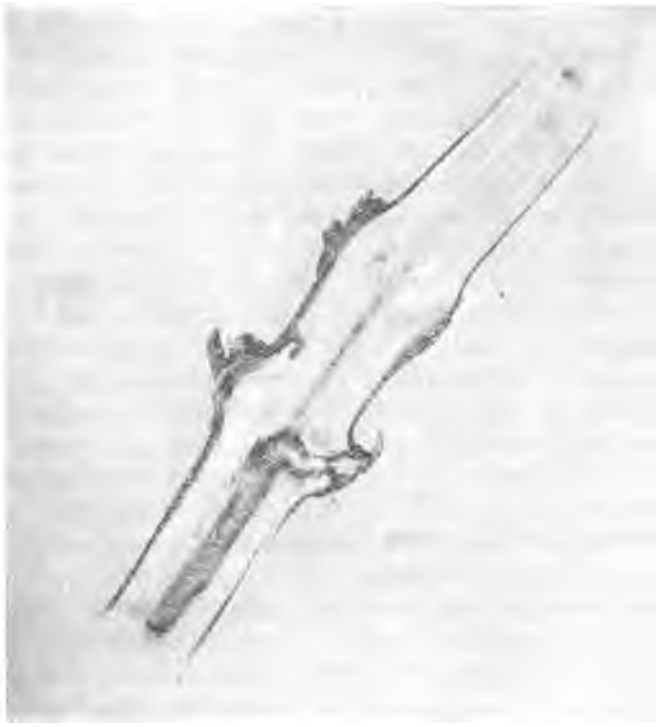
DEAD BRANCHES IN THE TOPS OF MAPLES USUALLY MEAN THAT A BORER IS AT WORK.

over by the wind, it is entirely possible that it may live to an old age. In selecting trees for forest planting, however, we must not base our conclusions on the few old veterans that have survived the attacks of the locust borers in the early days, for we do not know anything of the vast numbers of locust trees which must have succumbed to the attack of this beetle early in their life history.

Hickory Borer (Cyllene pictus). This beetle is almost identical with the locust borer except for the fact that it confines its work to the hickories and, also, in the fact that the adults appear in the spring of the year instead of the fall. For a long time it was supposed that the locust borer had two broods each year—a

spring and a fall brood—but it was later discovered that the spring form was not the locust borer at all, but the form under discussion. The beetle is not common in Indiana and is not a serious pest to hickory trees in this State.

The Oak Twig Pruner (Elaphidion villosum). This small beetle causes an interesting, though not serious, injury to oak trees and sometimes to trees of other species. The eggs are laid



OAK PRUNER AND ITS WORK.

in July on the twigs of the trees and the larva bores to the center of the twig toward the base, later eating away most of the woody tissue, so that the branch is held only by the bark. The larva then retreats into its burrow and plugs up the end of the boring with a plug of sawdust.

The insect depends upon the high wind to break off the branch at the point where the tissues are largely eaten away. In this way the larva reaches the ground in safety and the branch is kept moist on the ground among the dead leaves during the winter. The life cycle is completed in one year.

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[illegible] in parks and in lawns. In [illegible] a slight [illegible]

Tent Caterpillar (Malacosoma americana). This exceedingly [illegible] caterpillar winters in the egg stage and often as many as [illegible] hundred eggs occur in a single cluster. The young caterpillars hatch in the early spring, feed on the opening leaves and [illegible] great damage to a tree. The larvae build [illegible] nests or tents in which they remain except when they emerge for feeding. These nests frequently reach considerable size and are conspicuous and unsightly. The full-grown caterpillars are dark in color with bluish-yellow spots. Down the back there is a continuous line of white. The larval life is something over a month and the insect then enters the pupa stage in which it remains for a little less than a month. The adults emerge in the early summer and lay their eggs on the twigs for the next year. The Tent Caterpillar is a native American insect and its original food was doubtless the Wild Cherry, which it still attacks very frequently and usually in preference to the apple. It sometimes occurs in very injurious numbers in apple orchards however, and is a form which must be watched for and fought vigorously when it appears. In speaking of the first American apple trees Thoreau says, "The Tent Caterpillar saddled her eggs on the very first twig that was formed and it has since shared her affection with the Wild Cherry."

Being an active leaf-eater, this caterpillar is generally controlled by an arsenical spray. In orchards that are regularly sprayed for the Codling Moth there will be little to be feared from this form.

Bag Worm Moth (Thyridopteryx ephemeraeformis). This is one of the most important leaf-eating insects not only to shade trees but to orchard trees as well. It occurs over the entire State and is a cosmopolitan feeder, eating the leaves of a large variety of trees. It is especially bad on the Ash Leaf Maple or Box Elder, and is also notably injurious to the Arbor Vitæ. It is perhaps the worst pest to the evergreen trees that we have; defoliating almost any tree of evergreen and the defoliation is almost invariably followed by the death of the tree.

The young caterpillars emerge from their cocoons in early June and immediately spin cocoons of their own, which they carry

upright for several days, adding to the cocoon as they increase in size. The small bag or cocoon is soon too heavy to be carried in an upright position and it falls over to one side and is dragged about by the caterpillar during the rest of its feeding season. The caterpillars seldom ever emerge from this bag but carry it about with them while they are feeding on the leaves during the summer. They become full-grown about the last of August or the first of September. At this time, they attach their bags or cocoons to the twigs of trees where they are to remain during the winter. Late in September the adult moths appear, the females

BAG WORM. (Adult male).

never leaving the cocoon until after the eggs are laid. The eggs are laid in the cocoon previously occupied by the female cocoon and remain in this cocoon during the winter. This is practically the only case where we have the moth passing the winter in the egg stage inside of the cocoon.

Some of the East India tribes who believe in the transmigration of souls have the curious tradition that the bag-worm moths represent the souls of men who stole firewood while they were upon earth, and are paying for it by carrying these small bundles of twigs around on their backs during their insect life.

Being an active leaf-eater, the bag-worm moth is readily controlled by the use of any arsenical poison, such as Paris green or arsenate of lead. The arsenate of lead is preferable because it adheres better to the leaves.

The cocoons can also be gathered from the trees during the winter time and destroyed by burning. If all of the cocoons are removed from the tree, the tree can be protected the following summer by the use of some sticky banding material which will

prevent the larvæ from crawling up the trunk of the tree. Since the female moth does not fly, the worms can only reach the leaves by crawling up the trunk, and the use of any sticky preparation

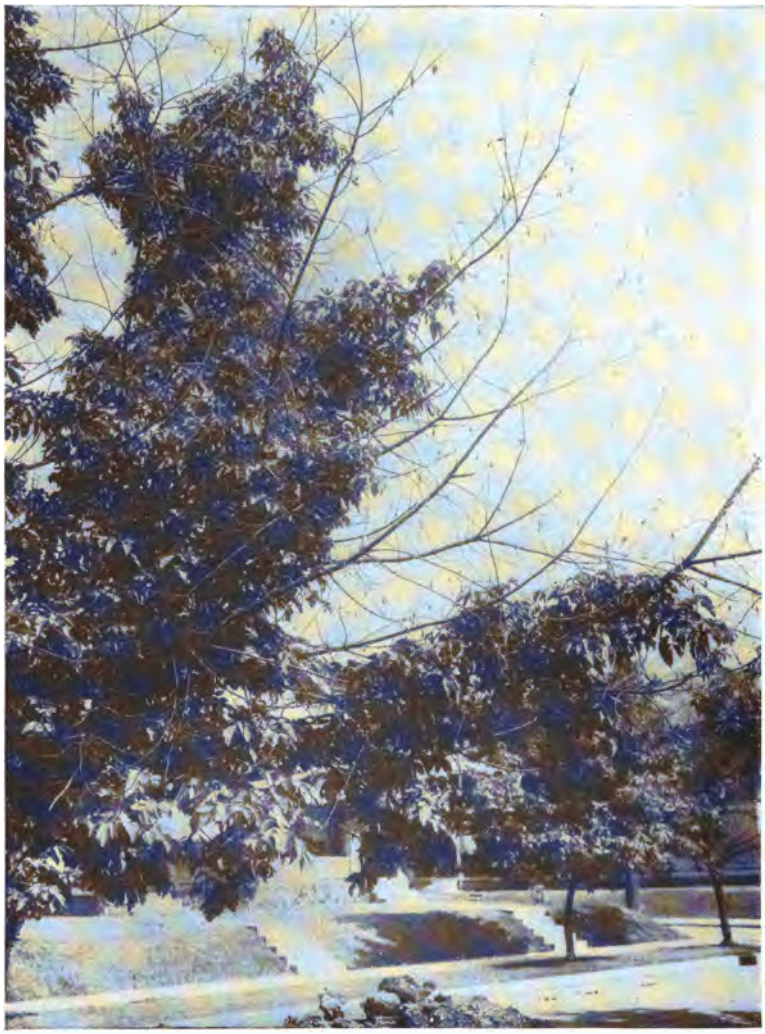
THIS TREE WAS FULL OF BAG WORMS WHEN THE PICTURE WAS TAKEN.
The leaves were nearly all eaten and the foliage effect is given by the quantities of worms.

on the trunk will prevent a reinfestation of the tree. In selecting banding materials for this purpose care should be used. No preparations containing tar or mineral oil should ever be applied to the trunks of trees. Ordinary cotton makes a satisfactory band-

TREE KILLED BY BAG WORMS IN INDIANAPOLIS.

A BAG WORM MOTH IN WINTER.

ing material but it is not lasting. It becomes ineffective after a few hard rains. One of the best materials that I have ever used is a preparation put out by the manufacturers of a brand of sticky fly paper. This sticky material is smeared on the trunk of the



TREE KILLED BY BAG WORMS.

tree in a narrow band and is convenient to use, remains sticky for a long time and the manufacturers claim that it will not injure the trees. I have never known of any tree to be injured by its use.

The Fall Web Worm (Hyphantria cunea). The larva of this moth is familiar to nearly everyone as being a common pest on many of out native and cultivated trees. The insect is perhaps most common on the wild cherry, where its large, ugly webs may

THE NEST OF THE FALL WEB WORM.

be found season after season. In habit the Fall Web Worm is similar to the tent caterpillar, though the latter may always be recognized as a distinct form simply because of the difference in season.

The Fall Web Worm occurs late in the year and builds a web as soon as the caterpillars hatch from the eggs, and does its feed-

NEST OF THE FALL WEB WORM REMAINS IN THE TREE ALL WINTER.

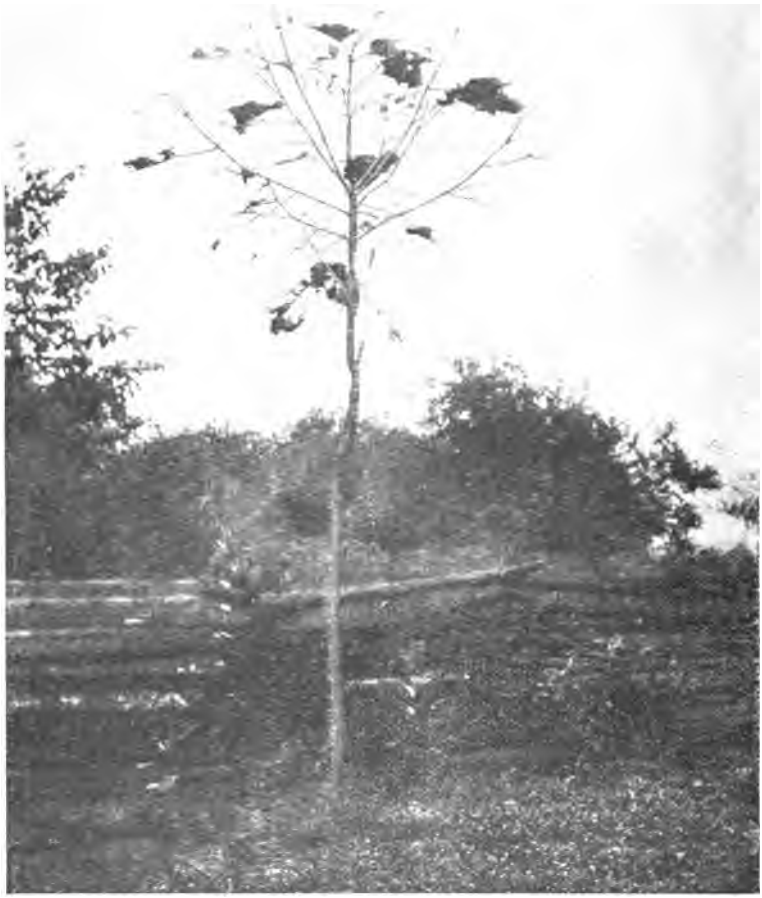
ing in and around these webs. The webs are persistent on the tree throughout the winter as a dirty, tangled mass of dead leaves and insect remains loosely bound together with coarse silk. The Fall

Web Worm passes the winter in the pupa stage in a loosely made cocoon, sometimes within the borders of the old web. Where the form occurs on cultivated trees the webs should be destroyed with a torch, and any living caterpillars which fall to the ground should be destroyed. A serviceable and simple torch for this purpose consists of a good-sized corncob soaked in coal oil and fastened to the end of a long pole.

LIFE HISTORY OF CATALPA SPHINX.

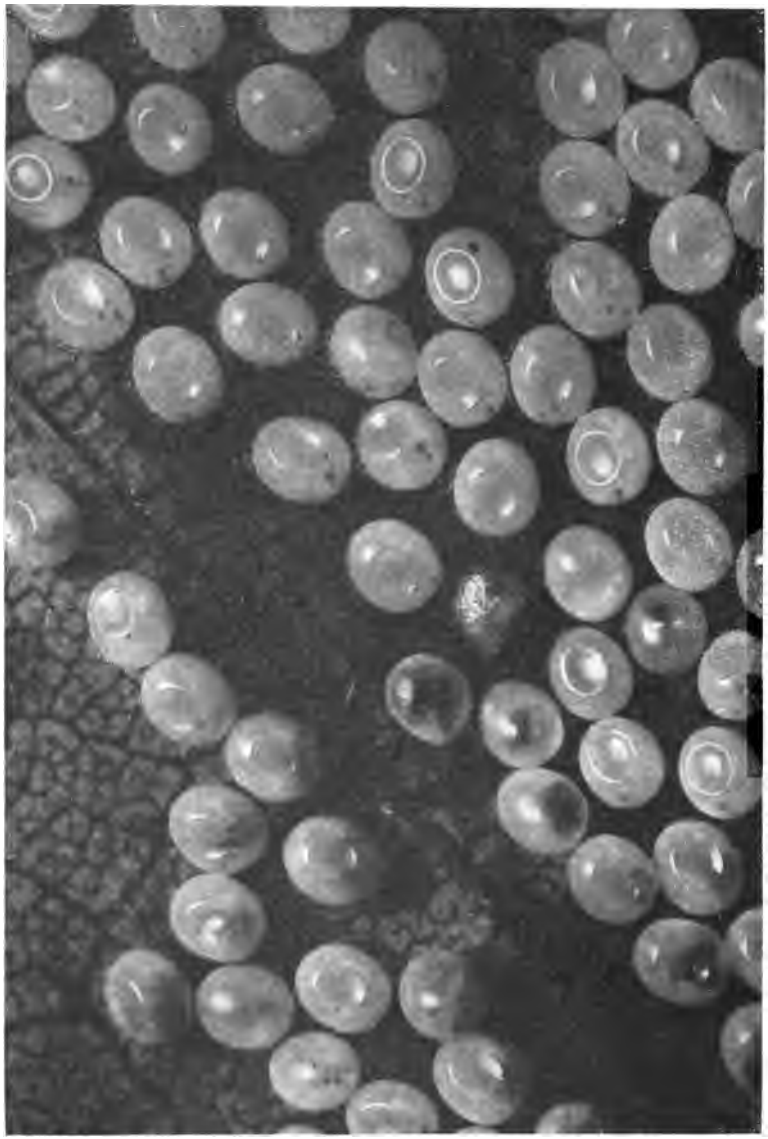
CATALPAS DEFOLIATED IN MID-SUMMER

Catalpa Sphinx (Ceratomia catalpæ). The Catalpa Sphinx Moth is distributed over the entire State and is now found in nearly every locality where the catalpa tree is grown. In some



DEFOLIATION BY CATALPA SPHINX.

regions it has proved a formidable enemy of catalpa plantings. I have seen plantations of the catalpa that were completely defoliated by this insect, and it is a common enemy of the young catalpa seedlings growing in the nursery.



EGGS OF CATALPA SPHINX ENLARGED

WORK OF SCOLYTUS

There are at least two broods of the insect each season, and in some localities there is possibly a third brood. The larva of the Catalpa Sphinx is light green, variable marked with black. Often the markings change as the caterpillar develops. At first the black markings may be confined to a few lines of spots. These spots will later merge together forming broad, black, velvety stripes running the full length of the insect.

The insect passes the pupa stage in the ground near the infested tree. The pupa varies from the typical Sphinx Moth in that it does not have the peculiar jug-handle tongue case.

Spraying with any of the arsenical preparations is quite effective in combating this insect, provided the trees are not too large. Arsenate of lead is perhaps the best preparation to use, as it remains on the trees for a longer period. Where the insect occurs in catalpa plantations the ground should be thoroughly plowed and harrowed in the fall of the year. This will destroy many of the insects, and if a few hogs can be turned into the area they will destroy the great majority of the pupæ.

The Engraver Beetle (Scolytus rugulosus). The Engraver beetles do excessive damage to many of the forest trees by boring between the bark and the wood. They have received their name because of the characteristic fashion in which they form their galleries in the living tissues. If the bark of an affected tree be peeled off, the tunnels of the insect will be found running out from one main central channel. This central portion is the brood chamber in which the adult beetle lays her eggs. The young larvæ bore in all directions from the brood chamber. As a rule, these insects attack only trees that have been weakened by some other agency, but when they do attack a tree they usually make short work of it, often destroying fine specimens. Sometimes only single branches are affected and in such cases it is well to cut off and burn the infested branch as soon as its condition becomes known.

Tussock Moth (Hemerocampa leucostigma). This is perhaps the worst leaf-eating pest that we have in the cities of Indiana. Many varieties of shade trees are attacked by it, but they are notoriously injurious to the Horse-Chestnut, Linden and the Maple. The Tussock Moth ranges throughout Eastern America, being a cosmopolitan insect both in range and food plant. In some seasons the larva of this moth is an exceedingly injurious form in the apple orchards where it is taken care of by the incidental spray-

ings which are part of the routine work in the management of any orchard.

There are, normally, two broods of Tussock Moths each season,

DEFOLIATION BY TUSSOCK MOTH.

although some seasons the third brood is developed. Often the third brood is killed by frost. I have often seen the caterpillars of the third brood as late as November, and it is doubtful whether

very many of these third brood caterpillars survive the winter. Normally, the insect passes the winter in the egg stage; the larvae appearing in the early spring. The adult moths mature some time in July, and the female moth usually lays the eggs directly on or very near the cocoon from which she has just emerged. These cocoons are very often built in sheltered places afforded by the overlapping weather-boards on houses and in large cracks in the bark of trees. This fact is an important

FEMALE OF THE TUSSOCK MOTH LAYING EGGS.

point in the control of the pest. If the eggs are not laid directly on the trees and since the female is wingless, it follows that any of the caterpillars that reach the leaf surfaces must do so by crawling up the trunk of the tree. Consequently, the damage from this pest can be completely prevented by banding the trees with some sticky material as has been recommended in the case of the Bag-Worm Moth. In case the larvæ should reach the leaves before their presence is detected they can be destroyed by spraying the trees with a solution of arsenate of lead in the proportion of 3 pounds to 50 gallons of water.

This is one of the native insects that is commonly controlled by parasites so that, as a rule, we do not have two years of severe Tussock Moth injury in succession.

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EGG MASS OF TUSSOCK MOTH.

The Elm Leaf Beetle (Galerucella luteola Mull). "This imported insect is, in all probability, responsible for more ruined elm trees in the Hudson River Valley than all other destructive agencies."—(E. P. Felt.)

This European insect has been injurious through the eastern States for the last 75 years, and has wrought a great deal of destruction to the elm trees of that section. During recent years, the insect has migrated to the Ohio River Valley and about six years ago made its first appearance in southern Indiana. I have seen elm trees completely stripped of their foliage in Harrison

ADULTS OF ELM LEAF BEETLES.

County, and the pest has become an exceedingly injurious insect throughout the southern counties. In the town of Corydon, the beautiful elm trees have been stripped of their foliage, and the famous Constitutional Elm, under which the Constitution of Indiana was written, has been somewhat injured by the work of this pest. The district of Kentucky, immediately across the river from Harrison County, is badly infested with the insect, as is most of the State of Kentucky. There is no reason to suppose that the insect will not spread northward through the State of Indiana, making, in this way, another argument in favor of discarding the elm tree as a tree to plant along our city streets. With the increasing number of pests which this tree has to face it is only a short time until the elm trees of our cities will be an expensive luxury.

LIFE HISTORY.

The adult beetles pass the winter in sheltered cracks and in trash and rubbish on the ground around the tree. When the young leaves unfold, the beetles begin to eat small round holes through

them. Many leaves are thus destroyed before the main brood of the insect appears. A little later in the spring the females lay small clusters of yellow, bottle-shaped eggs on the under side of the leaves. The egg laying period extends over about a month,

WORK OF ELM LEAF BEETLE. (Adult.)

each female laying several hundred eggs. In a little less than ten days these eggs hatch and the young larvae feed upon the under surface of the leaf, leaving the veins and the upper surface of the leaf intact. Thus differing distinctly in their injury from that

caused by the adult beetle, which eats the entire tissue of the leaf from surface to surface. The larvae require about three weeks in order to complete their full growth and at that time they crawl

WORK OF ELM LEAF BEETLE. (Larva.)

down the trunks of the trees and transform to the pupa condition, either on the surface of the ground or in some shelter which they find near the tree. They are sometimes found in enormous numbers protected by the pasteboard advertising signs tacked on

trees along the roadside. In about ten days the adult beetles appear and lay eggs for the second brood. This second brood is sometimes of more serious consequence than the first brood

WORK OF ELM LEAF BEETLE. (Larva.)

inasmuch as it causes a defoliation of the trees a second time, without giving them an opportunity to recuperate from the shock of the first defoliation.

The foregoing description is probably sufficient to enable anyone to recognize the pest should it appear in their vicinity, but

owing to the fact that this insect is entirely new to a large portion of Indiana, I will give the following complete description of the various stages.

The adult beetle is a dull yellow color and each wing cover has a distinct black stripe extending from the base of the wing to the extremity just along the outside edge. The legs and antennæ of the beetle are yellow. In size, the beetle is about one-fourth of an inch in length. The eggs are bright yellow in color and at first glance resemble the eggs of the Colorado Potato Bug, although a trifle smaller in size. They are packed in a group on the under side of the leaf in clusters from ten to thirty. The very young larva is dark and covered with small tubercles bearing black hairs, giving it the general color effect of being black. The larva increases in size rapidly and molts a number of times before becoming full grown. When it reaches its full length of about one-half inch, it is dull yellow in color and with two longitudinal black stripes along the back. The pupa is about one-fourth of an inch in length and bright orange yellow in color with small black hairs or spines. Under badly infested trees the pupa can be found in immense numbers in their season and it is a good plan to gather them at this time and destroy them. This can be done either with the use of gasoline or with boiling water.

Dr. W. E. Britton reports the fact that one of the most important natural enemies of the Elm Leaf Beetle in Connecticut is the fungus which is known to botanists as Sporotrichium globuliferium. This fungus attacks the pupa and adult in the late summer, especially in moist seasons. During the past season we found this fungus prevalent to considerable extent on the insects which appeared in Harrison County, contrary to Dr. Britton's statement. This insect was unusually noticeable the past season, which was a very dry one in southern Indiana. The insects which are attacked by this fungus appear covered with a white mold. While this fungus will no doubt materially assist in keeping the pest under control, it must not be depended upon for too much. Wherever the insects appear the trees will have to be sprayed with a solution of arsenate of lead at the rate of 3 pounds to 50 gallons of water. By spraying the trees early in the spring as soon as the adult beetles appear, the later injury from the larvae can be prevented to considerable extent. In some sections of the east they prefer to wait until the young larvae are hatching and then spray the trees thoroughly at that time. It is claimed by some that with this practice a single spraying is sufficient to con-

trol the pest, whereas in the early spraying for the destruction of the adult beetle it is sometimes necessary to repeat the spray several times, owing to the fact that it is liable to be washed off by the spring rains. The later application applied for the destruction of the larvæ is put on after the spring rains have stopped, and the poison usually remains on the leaves throughout the summer.

Spiny Elm Caterpillar (Vanessa antiopa). This caterpillar is the larval stage of an exceedingly beautiful and interesting butterfly known as the Camberwell Beauty. The adult butterfly passes the winter sheltered in some hollow tree or other protected place

ADULT OF SPINY ELM CATERPILLAR.
(Camberwell Beauty Butterfly.)

and appears with the first warm days of spring, for it is our earliest butterfly. The eggs are laid in masses on the twigs of elm and sometimes on other trees. The young larvæ feed on the opening buds and young leaves of the trees, very often doing extensive injury by defoliating large branches or even whole trees. The insects rarely appear in injurious numbers two years in succession, owing to the fact that they are kept under control by various parasites. Wherever they do appear in large numbers, they can be destroyed by spraying the trees with arsenate of lead as recommended for the Elm Leaf Beetle.

SPINY ELM CATERPILLARS ON LEAF.

GRAPTA SP. IN WINTER.

SEMICOLON BUTTERFLY.

A NEST OF WALNUT WORMS.

Grapta Interrogationis Fab. This butterfly has a similar life history to the Camberwell Beauty and its injury is almost identical with that species. It also confines its depredations almost exclusively to the elm.

The Walnut Worm (Datana integerrima). The Walnut Worm is the larva of a pretty brown moth which is frequently captured by collectors in native woods. The larva confines its feeding almost exclusively to the walnut and hickory trees, where it feeds

LARVA OF WALNUT WORM.

in compact colonies. The worms are quite dark in color and have conspicuous long, white hair. It has the interesting habit of crawling down the trunk of a tree and gathering in a cluster at moulting time. If the trees are carefully watched, these clusters can readily be gathered and the larvæ destroyed mechanically. The larva is well illustrated in the accompanying cut.

The June Beetle (Lachnosterna sp.). The June Beetle or "June Bug" is a common insect late in spring or early summer.

The larva live in the sod, feeding on the roots of grass and other plants and are the common "white grubs." Serious damage is often done to pasture lands. Deep fall ploughing and the use of kainit at the rate of half a ton per acre will drive out most of the insects.

ASH TREE DEFOLIATED BY "JUNE BUGS."

The adults are night flyers and often injure the foliage of trees and shrubs. During the last season some of the white ash trees in Crown Hill Cemetery were completely defoliated by this beetle. Since their work is done at night it is sometimes puzzling to the observer, who is unable to find an insect at work during the day. As a rule, the damage is done early in the evening between dusk and 10:00 o'clock. Arsenic in any form is, of course, effective.

The complete life history of the several species is not clearly recorded either as to the length of the larval period or as to the time of emergence of the adult. The latter seems to vary considerably and I have found recently transformed specimens from May till mid-autumn.

SEVENTEEN YEAR LOCUSTS.

The Seventeen Year Locust (Tibicen septendecim). The Seventeen Year Locust, or Periodical Cicada as it is more properly called, occasionally injures shade trees by laying eggs in the smaller twigs. The injury is but slight, however, and the fact that it occurs only once in seventeen years makes the insect a form which needs receive but little attention from the tree growers.

The eggs are usually laid in rough slits cut in the under side of the twig and as soon as they hatch the young Cicadas fall to the ground where they immediately bury themselves to feed on the roots of plants during the balance of their period of development.

EIGHT-SPOTTED FORESTER A COMMON MOTH.

SCALE INSECTS OF INDIANA.

In the previous reports I have treated of the more important scale insects which occur in this State and have given directions for their control. Many minor forms were left out of the former publications and it is my desire at this time to present a complete list of the scales known to occur in the State. I realize that an extended account of obscure forms would be out of place in a document intended to be strictly economic in its character. As a result most of the descriptions will be as brief as is consistent with a clear understanding of the identity of the insect. The accompanying cuts will also tend to reduce the necessity for long technical descriptions. The different species are arranged in the order given them in Fernald's Catalogue of the Coccidæ of the World and the nomenclature of that catalogue has been followed. Whenever there has been any doubt of the identity of a specimen, I have had my determinations verified by Dr. L. O. Howard of Washington, whom I desire to thank for his assistance in this line and for many other favors extended to me. I am also indebted to my assistant, Mr. Harold Morrison, for several new records, especially in the genus Kermes. All of the photographs accompanying the descriptions are originals prepared by or under the direction of the writer.

UNDERSIDE OF LECANIUM SCALE. (Magnified.)

[10—28403]

Scale insects are so called because of the fact that many of them secrete a peculiar substance which forms a distinct shell or scale over the body of the insect. This shell is simply a protective covering of the soft body of the insect proper. Thus it will be seen that when we look at a branch badly infested with, let us say, San Jose scale we do not see any of the insects themselves but only the protective scales with which they are covered. If this scale should be carefully removed we would find the soft yellow body of the insect under it. In the case of the large, rounded scales such as the "Lecaniums" we find this scale plate becomes a portion of the body wall of the insect. It might be compared with the carapace or the top shell of the turtle. The scale insects belong to the Hemiptera, a great group of injurious insects all of which obtain their food by sucking the juices from the plant on which they feed. The group comprises many of our most injurious insects, some of which are exceedingly difficult to control. Some of the most serious forms have been introduced into this country from other countries, largely on nursery stock and it is on nursery stock that scale insects are still distributed to a very large extent. The adult females can not fly and as a result the insects normally reach a new locality only by crawling or by being carried by the wind or on the feet of birds.

It has been claimed by some writers that birds are the principal natural agency for the dissemination of the scale insects, and some writers have been bold enough to assert that if all the birds could be destroyed that all of the scale insects would become extinct within a comparatively short time. The writer who suggested such a possibility of course did not do so with a view of recommending that birds be exterminated on this account. The value which they do in destroying other injurious insects far outweighs what little harm they may do by distributing scale insects. I am satisfied in my own mind that many scale insects reach new food plants by being carried on the wind. The young scales are exceedingly minute and can easily be carried a distance of a number of yards.

The different species of scale insects vary considerably in their breeding habits. Some forms having only one brood a year, others having many broods. Many forms pass the winter in the egg stage, while others, such as the San Jose scale, pass the winter as more or less mature insects and the first brood of young are born alive the following spring. The variation in the breeding habits of the

insects has an important bearing on the control measures to be adopted for any special form and special emphasis will be laid on this point from time to time in the discussion of the different species.

CONTROL OF THE SCALE INSECTS.

Thirty years ago, the problem of the control of the scale insects was a comparatively simple one in America, but at about that time the San Jose scale made its appearance in California and has been spread over the entire country—becoming our most injurious scale insect. Had there been an efficient inspection system in America at that time the San Jose scale would never have obtained a foothold, and had there been anything like a reasonably efficient inspection system in Indiana fifteen years ago the San Jose scale could have been stamped out when it first appeared. Neglect at that time, however, meant that the scale was to spread over the entire State so that we find it in practically every county today.

The problems connected with the control of the San Jose scale do not differ greatly from the problems of the control of any scale insect. All of the scales are sucking insects and obtain their food, as has been stated, by sucking the juices of plants. Consequently, to destroy them we must employ some preparation that will kill them by contact, as it is obvious that a poison like Paris green or arsenate of lead which acts internally would not be effective in controlling a pest which obtains its food from the interior of plants. Perhaps our most prominent insecticide at this time is the lime-sulphur solution which is so widely used throughout the country today. Unquestionably the most satisfactory solution that can be used for the control of any scale insect is what is termed the Standard Lime-Sulphur Solution. This solution is prepared by boiling for at least one hour 50 pounds of lime, 50 pounds of sulphur and 150 gallons of water. This formula can be used in any proportion and will give excellent results in the control of scale insects, provided a good quality of lime is used and also provided that the solution is cooked for the specified time. There is no reason why the solution should not be just as effective applied cold as applied hot, although some writers recommend that the solution go on the trees while it is warm. In my experience, I have never seen that anything was gained for applying the solution while it was still hot. Certainly nothing is lost by allowing the solution to become cold. Very often there will be considerable quantity of the solution left at the end of a day's spraying and

this would be wasted if the former recommendation of applying it to the trees hot was followed. The concentrated commercial lime and sulphur solutions that are now put on the market have shown themselves to be fully equal to the home-made preparation. They are not quite as cheap as the home-made solution but the saving in time is sufficient to make up the difference in price. The so-called miscible oils had quite a vogue through the country a few seasons ago, but I believe that they are now largely replaced by

TREES WELL SPRAYED WITH LIME AND SULPHUR.

the commercial lime-sulphur preparation. I am sure that this is the condition in Indiana at least. These oil preparations never gave entirely satisfactory results in the destruction of scale insects and in a number of cases they appeared to be positively injurious to the trees.

It is interesting to know that the present system of nursery inspection that is in force over the United States was brought about largely through the introduction of the San Jose scale. This insect from Northern China was first brought to California and from there to a certain section in the East where it was widely disseminated by a nursery firm in New Jersey. I should not wonder if the San Jose scale had not almost paid for the damage it has wrought simply by creating an interest in the possibility of introducing injurious insects from abroad. An especially careful watch is now kept on all shipments of nursery stock entering America from any foreign country because of the great danger of

introducing still more injurious forms. Under the horticultural laws of the various States it is illegal to sell nursery stock that is infested with San Jose scale or with any other injurious insect. This has necessitated the development of some system of treatment of infested nursery stock so as to render it safe for planting and, at the same time, so as not to reduce the vitality of the tree. The fumigation with hydrocyanic acid gas has been demonstrated to be fully effective for this purpose and is widely employed throughout the country today. Some States require that all nursery stock sold shall be fumigated according to the recommendation of the entomological department of that State. These recommendations are practically uniform for the entire country and require that the trees be exposed to the vapor of hydrocyanic acid gas for a period of forty-five minutes. This gas is prepared by adding potassium cyanide to dilute sulphuric acid. For each one hundred cubic feet of space in the fumigating house the following formula is used.

Water, 4 oz.
Sulphuric acid, 2 oz.
Cyanide, 1 oz.

The cyanide must be pure and fresh if good results are to be obtained. The water and acid are mixed and placed in a crock or jar that will not be affected by the acid. The cyanide is placed in a paper bag and dropped into the jar the last thing before closing the door of the fumigating house. Lose no time in getting out of the house and closing the door as the fumes which are generated immediately are intensely poisonous.

THE FUMIGATING HOUSE.

The house in which the trees are exposed to the gas must be made so that it is absolutely air-tight. This can be accomplished by making the walls double and placing two layers of heavy building paper between. Do not attempt to make an old shack fit for fumigating purposes by covering it or lining it with paper. Use great care to see that the roof is tight. This is one of the most serious drawbacks to successful fumigation. The gas is very light and if there is a slight leak in the roof all of the gas will escape before the scales have been killed. Many growers have built houses of cement. These are by far the best, as they are tight, and during the winter they may be used to store tender plants. They are also fairly cheap to build when you consider that they never

need repairs. The house should be made with a door than can be easily opened but that fits tight. A rope fifteen feet long should be tied to the handle of the door with which to pull it open at the end of the fumigation period. A window should be provided in the back of the house and near the top. This window must be opened from the outside the same way the door is. This is to allow the escape of any gas that might collect in the top of the house above the level of the top of the door. The light gas may form a pocket in the top of the house and remain there for hours after the door is opened. Do not enter the house for an hour after it is opened. It is a good plan to dig and store the stuff in the house durnig the day and at night fumigate as above for forty minutes. Then open the house and let it stand till the next morning when the stock can be removed in safety.

Some nurserymen have attempted to economize by building their houses with a partition door that can be used to reduce the size of the fumigating compartment and thus use less material. These doors can not be made tight and as a result the work that is done in them can not be effective.

Greenhouses are fumigated with a much weaker charge of the gas producing chemicals.

Find the cubic content of the greenhouse to be fumigated and multiply the number of cubic feet by 0.15; the resulting figure will be the number of grams of cyanide to use for the house. (One gram equals about 15 grains.) For each part of cyanide use two parts of sulphuric acid and four parts of water. The method of measuring triangular shaped houses was fully explained in my first annual report.

LIST OF SCALE INSECTS.

98. *Orthesia insignis* (Dougl.).

THE GREENHOUSE ORTHESIA.

Unlike most of the scale insects, this insect is not fixed but has the power of locomotion and can crawl from place to place like the common mealy bugs. It is common in many greenhouses, where it attacks principally the coleus. Owing to the temperature conditions in greenhouses this pest is enabled to breed throughout the year, but the exact number of generations has not been worked out to my knowledge.

The insects can be controlled by spraying with a whale oil soap solution, but the most effective results are to be obtained by the use of hydrocyanic acid gas in the greenhouse. Full directions for the use of this method are to be found following this list of species.

233. *Kermes andrei* (King.).

This round scale was found by Mr. Morrison on white oak near Noblesville. It is of no economic importance. The cut will enable it to be readily recognized.

242. *Kermes galliformis* (Riley.).

This kermes was found in Brown and Marion County by Mr. Morrison. It is fairly common on oaks. The following description is by Professor King: "A large, dark gray form, which turns to a nearly white color when exposed a season on the twigs. * * * viewed with a hand lens the scale is seen to be covered with minute black specks. Newly hatched larvae dirty gray."

254. *Kermes petiti* (Erhr.).

This scale is recognized by the fact that it is broader than it is long. It varies in color from light to dark brown more or less mottled.

GREENHOUSE ORTHESIA. (Much enlarged).

KERMES ANDREI AND EULECANIUM COCKERELLI.

KERMES ANDREI

255. *Kermes pubescens* (Bogue.).

This interesting scale was found by Mr. Morrison on oaks in Indianapolis and in woods near the city. The individual scales are quite large and covered with a distinct down or pubescence. This character is shown in the cuts.

KERMES PUBESCENS.

391. *Phenacoccus acericola* (King.).

WOOLLY MAPLE LEAF SCALE.

The under sides of maple leaves are sometimes almost covered with a waxy white powder. The powder is bunched in masses of varying size up to one-fourth inch in length and these masses contain living or dead female scales. The male scale is winged (in

the adult) and is red in color. The insect passes the winter in a half grown condition, hibernating in cracks in the bark of the tree. At this period the pest is easily destroyed by the use of the

KERMES PUBESCENS (Enlarged).

lime and sulphur solution. The spray should be directed especially to the forks of branches and to the base of the larger limbs as the larvae are most abundant at these places.

WOOLLY MAPLE LEAF SCALE.

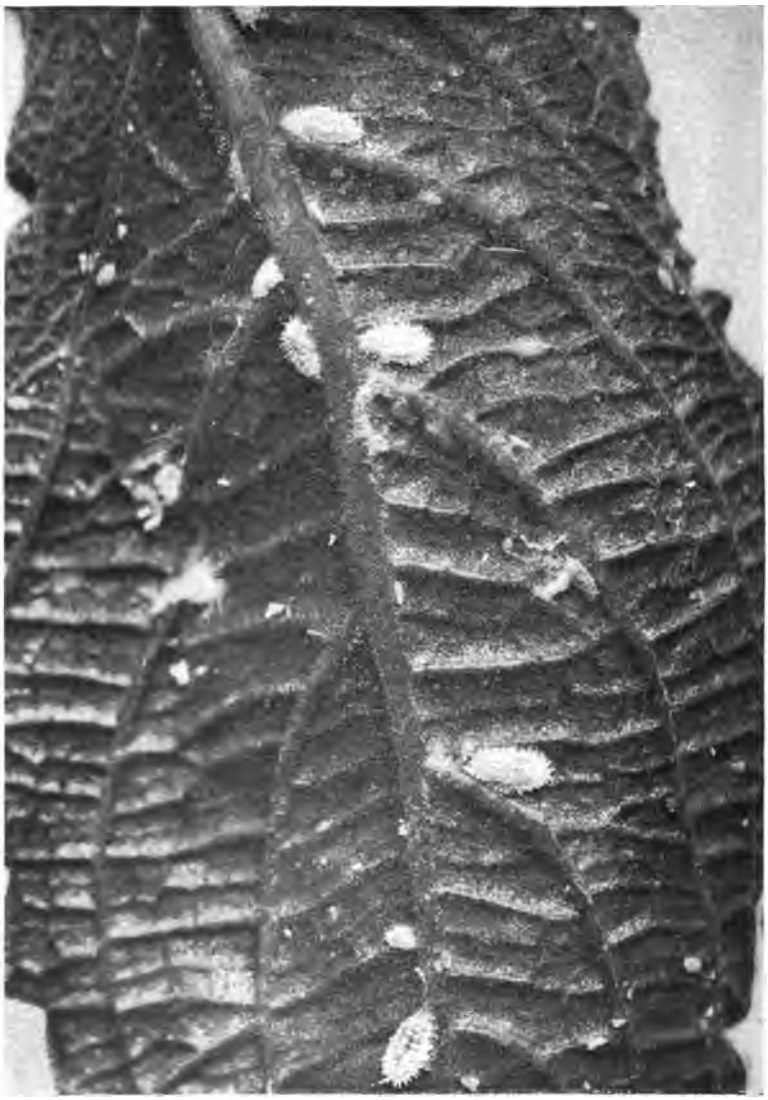
454. *Pseudococcus citri* (Risso).

MEALY BUG.

Like the orthesia the mealy bugs are able to move about on their food plant or to migrate from one plant to another.

COMMON MEALY BUG.

They are common on greenhouse plants and very often breed on plants growing out of doors in summer. Like the orthesia this species prefers the coleus to any other plant.



COMMON MEALY BUG. (Enlarged).

It is probable that the pest lives over winter in greenhouses and escapes to the open each spring.

The adults are well described by their name, but for more certain identification the reader is referred to the accompanying cuts.

Fumigation or the use of whale oil soap are advised as treatment.

490. *Pseudococcus longispinus* (Targ.).

LONG SPINED MEALY BUG.

This pest is closely related to the preceeding but differs from it in having two prominent caudal spines longer than the body.

PSEUDOCOCCUS LONGISPINUS.

The species is figured herewith. This insect is not common in Indiana but is sometimes found when inspecting greenhouses in connection with our import inspection work. It is controlled by the same treatment advised for the above.

506. *Pseudococcus pseudonipae* (Cock).

This uncommon Pseudococcus has been found in several greenhouses during the course of the inspection of foreign nursery stock. It is well illustrated in the accompanying cut.

PSEUDOCOCCUS PSEUDONIPAE.

638. *Pulvinaria acericola* (Walsh & Riley).

COTTONY LEAF SCALE OF THE MAPLE.

This insect is a close relative of the cottony maple scale, which it resembles to a very great extent. It has been found in several localities in the State but never to such an extent as to cause any

apprehension as to its becoming a serious pest. The insects pass the winter attached to the twigs much like the cottony maple scale. Early in spring they migrate to the opening leaves and attach themselves to the under surface. A white cottony mass is formed by the adult female scale and in this mass are to be found the eggs and young. This egg mass is characterized by four prominent ridges running lengthwise of the mass. When the young hatch they feed on the leaf juices and later migrate to the twigs where they are to spend the winter.

It will be seen that the insect makes two migrations in its life history which may account for the fact that it is not usually a serious pest.

668. *Pulvinaria innumerabilis* (Rathvon).

COTTONY MAPLE SCALE.

Next to the San Jose scale this insect has done more damage to Indiana trees than any two scale insects put together. It is of common occurrence over the State but is more common in the north part than in the south. In some cities of northern Indiana this pest has caused great damage to the silver maples and in recent years has attacked the native hard maple, often spreading from the locality of the town into the surrounding timber land. I have found it in the woods far from any town, on not only the various maples but on the linden and elm as well. Ordinarily, however, we think of it as a pest of city streets.

The adult scales pass the winter attached to the under sides of the twigs of trees. Early in the spring these scales develop a conspicuous white egg mass and the young scales soon make their way to the undersides of the new leaves and green twigs where they attach themselves for the rest of their life period. The scales that attach to the leaves perish in the winter when the leaves fall to the ground and those on the young twigs carry the pest over the winter. There is only one brood a year.

The leaves on badly infested trees are often so badly covered that they fall during the middle of the summer, first turning yellow. As a rule the tree does not die for several seasons after it first becomes infested. The first infestation may seem trivial and probably will attract no special attention, but it is at this time that the insect can best be exterminated. If an infested tree is allowed to go untreated it is only a matter of time until it succumbs

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COTTONY MAPLE SCALE.

TREE ALMOST KILLED BY COTTONY MAPLE SCALE.

Often the tree will be killed with the exception of a single branch. This branch may remain alive for several seasons after the rest of the tree is dead.

COTTONY MAPLE SCALE ON LEAF IN SUMMER.

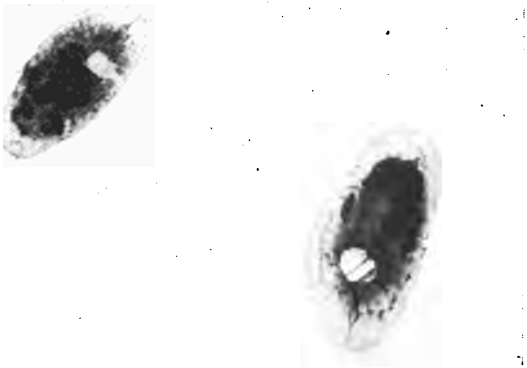
to the work of this pest. It is a characteristic of the insect that it attacks trees and kills them branch by branch. Otherwise healthy looking trees often show the work of this scale by dead branches

COTTONY MAPLE SCALE IN WINTER. (Enlarged).

in the tops. Sometimes a tree will be killed with the exception of a single branch which for some reason escapes the effects of the insect.

The fact that the scales attach themselves to the under sides of the twigs makes this a comparatively easy scale to control. The individual scales are in a position where they will be easily hit by the spray solution directed from the ground. The proper

solution to employ is the lime-sulphur wash made by boiling 50 pounds of lime and 50 pounds of sulphur in 150 gallons of water at least an hour. This home boiled mixture can be omitted and a commercial solution use. The commercial solution is obtainable in concentrated form and should be diluted with nine volumes of water so that each gallon of the commercial solution makes ten gallons as it goes on the tree. The solution should be applied as soon in the fall as the leaves are off the trees.



COTTONY MAPLE SCALES THAT HAVE BEEN KILLED BY PARASITES
Notice exit holes in shell.

699. *Pulvinaria vitis* (Linn.).

COTTONY GRAPE SCALE.

This member of the genus Pulvinaria resembles the cottony maple scale very closely. It has been found in two localities in southern Indiana and in Indianapolis. The life history is similar to the Cottony Maple Scale, but unlike that pest it seldom does any considerable damage. In case it should increase to a serious extent the measure advised against its relative will be found effective for its control.

848. *Coccus hesperidum* Linn.

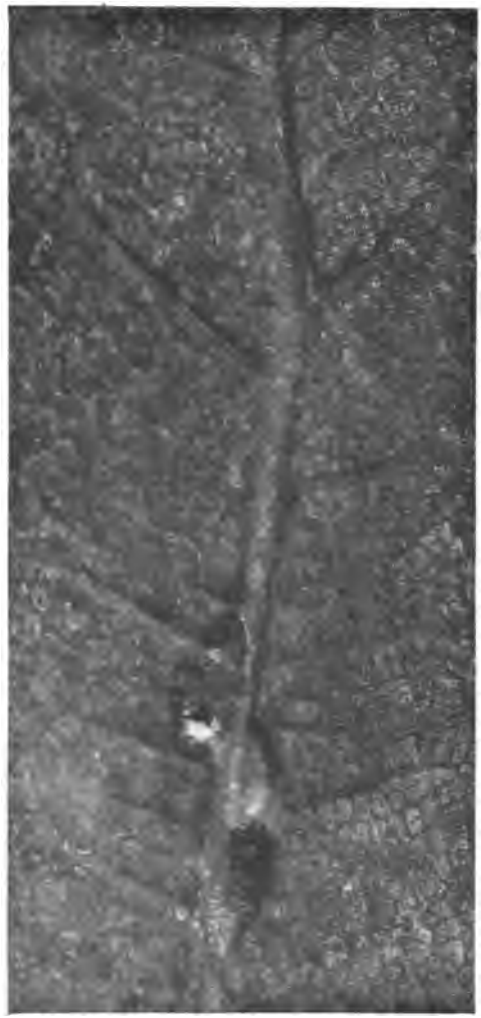
SOFT SCALE.

This small brown scale is a common pest of greenhouse plants and is very common on a certain class of tender shrubs like oleander, lemon and so on. The soft-bodied, light brown scales attach themselves to the leaves—usually along the veins. The tender

SOFT SCALE.

twigs are often attacked also. The insect is well shown in the accompanying cuts.

The infested plants may be sprayed with whale oil soap or with a dilute lime and sulphur solution. I have used the commer-



YOUNG OF THE SOFT SCALE.

cial solution diluted one to twenty with very good success and with no injury to the foliage of lemon. I am not able to say what effect this solution would have on other greenhouse plants as I have never tried it. The scales are also readily killed by the hydrocyanic acid gas fumigation.

913. *Eulecanium aurantiacum* (Hunter).

OSAGE LECANIUM.

This unimportant scale was found on an old osage hedge near Lawrence, Indiana. The mature scales are about an eighth of an inch in diameter and of a dark brown color. All that I found were parasitized and I have no reports from other localities.

EULECANIUM CARYAE

918. *Eulecanium caryae* (Fitch).

HICKORY LECANIUM.

This common lecanium is to be found on twigs of hickory, walnut, elm and other native forest trees. Individual specimens are almost hemispherical in shape and of a dark brown color. Like most of its allies it is controlled by parasites and seldom does any considerable damage.

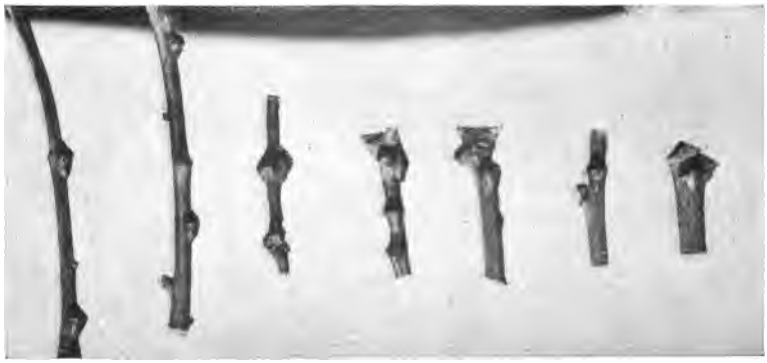
EULECANIUM CARYAE.

924. *Eulecanium cockerelli* Hunter.

COCKERELL'S LECANIUM.

While this species has been technically described it is now considered to be simply a distorted form of E. caryae. The

SMALL BLACK BEETLE EATING EULECANIUM CARYAE. (Enlarged.)



EULECANIUM COCKERELLI.

"species" is characterized by two prominent humps as shown in the cut. All specimens of this sort are found to be parasitized, which accounts for the distorted form referred to.

925. *Eulecanium corni* (Bouche.).

This small light brown lecanium is becoming common in the central part of the State. I have found it in and around In-

EULECANIUM CORNI.

dianapolis and in some cases it is doing considerable damage. In the city nurseries at Riverside Park this form was found on the sweet gum in numbers sufficient to cause serious results. The in-

festation was taken in hand promptly by the superintendent of the nursery and by cutting and spraying the species has been practically exterminated.

At another place in Riverside Park I found the species on hackberry to such an extent that branches had been killed. Like

EULECANIUM CORNI.

most other lecaniums this species is heavily parasitized and a season of severe injury is followed by a period of comparative freedom from injury.

I have also found the species on elm, euonymus and have it reported from Wabash County on walnut and "fruit" trees.

Wherever the species is found it should be handled exactly like San Jose scale and its natural enemies should not be depended upon to hold it in check. The lime-sulphur wash will be found entirely satisfactory as a winter spray.

935. *Eulecanium fletcheri* (Cock).

This Eulecanium was found on Arbor Vitae north of Indianapolis. It is an unusual form and is, I think, the only eulecanium recorded on conifers in this State. The individual scales are hemispherical and light brown in color. It is an insect of no economic importance.

EULECANIUMS THAT ARE INFESTED BY A PARASITIC FUNGUS.
Notice the rod shaped projections on the scales. (Enlarged.)

950. *Eulecanium nigrofasciatum* (Perg.).

TERRAPIN SCALE.

This interesting lecanium is reported from a few localities in northern Indiana where its work is confined to the silver maple.

EULECANIUMS THAT ARE INFESTED BY A PARASITIC FUNGUS.
Notice the rod shaped projections on the scales.

The adults are readily recognized owing to the fact that no other lecanium is so brightly colored. The general color is brown con-

spicuously marked with red and black giving the insect the general appearance of a painted turtle.

In some localities in the East this scale has attracted a great deal of attention as a pest of the peach and some States have issued warnings to the peach growers to be prepared to fight the pest in their orchards. The injury is not so much to the tree as to the fruit. The insects excrete a large quantity of the sub-

TERRAPIN SCALE.

stance known as honey dew and this collects on the fruit and furnishes a medium for the growth of a black fungus. In this way the peaches are rendered unsightly and unfit for market.

Professor Symons of Maryland has done considerable experimental spraying for the control of this scale and states that the lime-sulphur solution is not effective as a control measure. A series of experiments showed that the only solution that could be depended upon was one of the so-called miscible oils diluted one to fifteen. This solution was found to be effective if applied in the spring just before the buds opened. Some injury to the tree

is to be expected where miscible oils are used, but it is found that this injury is less in the spring than at any other time. Professor Symons advises the use of the oil to control the scale and states that it is better to risk some injury to the tree than to suffer the continued loss of crop by the work of the insect.

TERRAPIN SCALE. (Enlarged.)

972. *Eulecanium tulipiferae* (Cook).

This lecanium is confined to the tulip tree (yellow poplar of commerce) and sometimes does considerable damage. The large brown insects sometimes become so thick on the tree that they completely cover the branches, as shown in the accompanying cut.

[12—28403]

There is only one brood of the insects each year. They appear in early summer and the young at once migrate to the tender twigs where they may be found in large numbers.

This scale was first called to my attention by Mr. J. J. Milhous of Valley Mills, who reported it on a tree near that town. The photographs were made from Mr. Milhous's specimens. Since that time it has been reported from Darlington and from Cass County.

A BAD CASE OF TULIP SCALE.

Winter spraying with the lime and sulphur will give good results in controlling this pest. The spray is best applied just after the leaves fall in autumn.

TULIP SCALE.

YOUNG TULIP TREE SCALES.

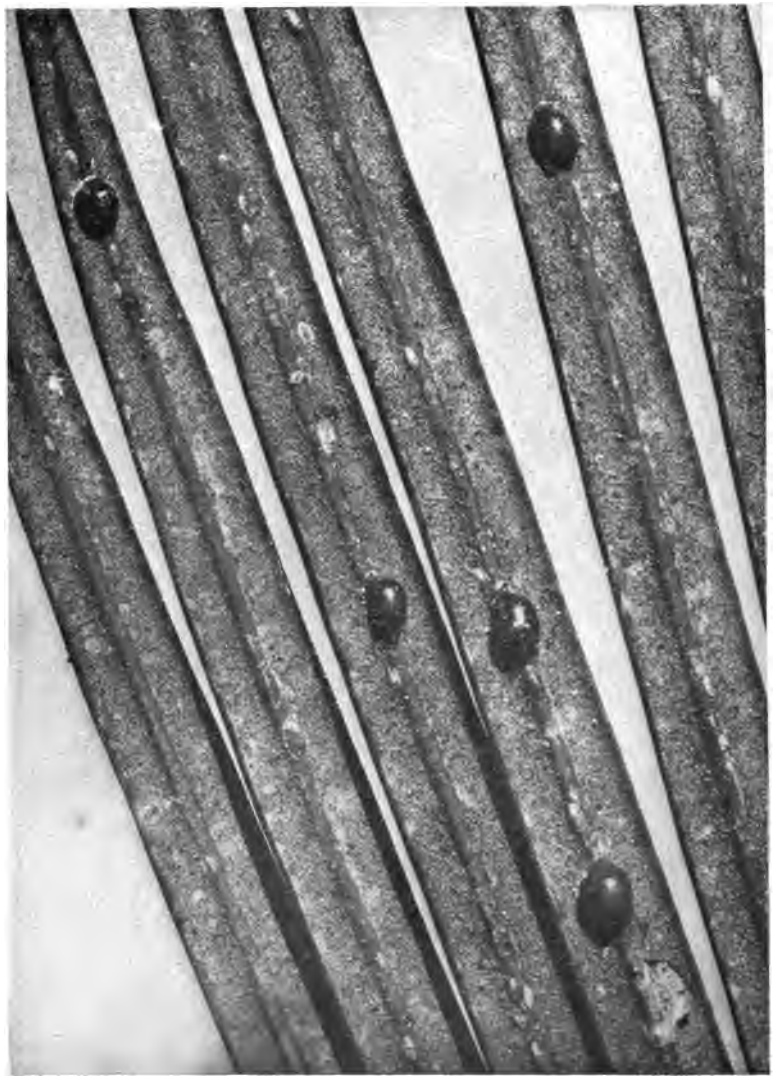
YOUNG OF THE TULIP SCALE. (Enlarged.)

EULECANIUM HEMISPHERICA.

993. *Saissetia hemispherica* (Targ.).

HEMISPHERICAL SCALE.

This small, hemispherical lecanium is a common pest in greenhouses, where it is especially common on the Boston fern. Badly infested specimens should have the worst injured fronds removed



HEMISPHERICAL SCALE. (Enlarged.)

and the balance of the plant should be dipped in a solution of whale oil soap. Fumigation with hydrocyanic acid gas will also be found effective.

BLACK SCALE

998. *Saissetia oleae* (Bern.).

BLACK SCALE.

This scale was found in one Indianapolis greenhouse on a plant of ficus. The scales are easily recognized owing to a prominent H-shaped ridge on the dorsal surface. In California this scale is regarded as the worst scale insect that they have to contend with. In that State it is combatted by both spraying and

fumigating. In some counties as much as $200,000 per year is spent in fumigating orange trees for this pest. With us it will remain as an occasional greenhouse pest as it doubtless can not survive our northern winters.

THE BLACK SCALE. (Enlarged.)

Quantities of honey dew are given off by the scale and on this sticky substance a black fungus grows. This fungus sometimes covers the leaves and does quite as much damage as the scale itself.

1036. *Chionaspis americana* (Johnson).

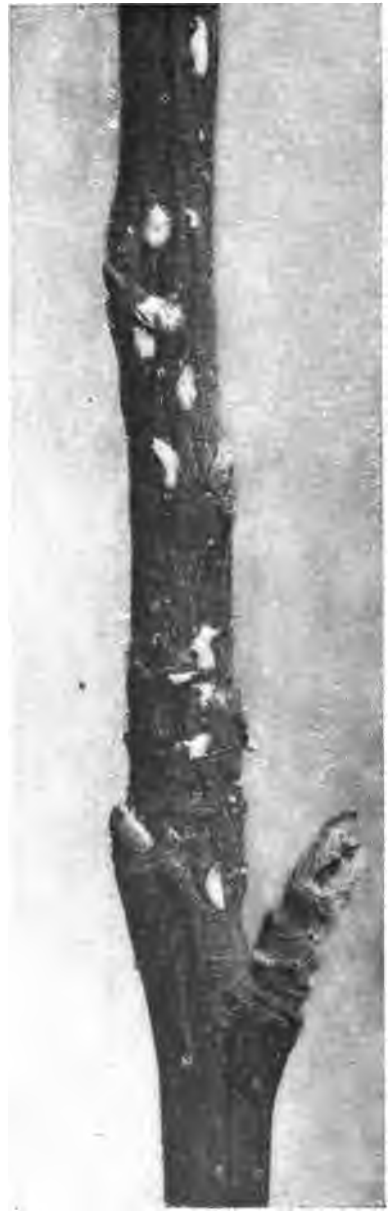
ELM SCALE.

This common scale resembles both the common scurfy scale and the oyster shell scale, although it is not related to the latter. It

ELM SCALE.

occurs on elms in many parts of the State and in some localities does considerable damage to this tree. The trees around the state house in Indianapolis were formerly crusted with this species, in

TWIG BADLY INFESTED WITH SCURFY SCALE. (Enlarged.)



SCURFY SCALE.

spite of the fact that a local tree doctor had sprayed them each year with a "secret" preparation for killing "scale." After some difficulty I induced the custodian of the building to purchase a small spraying outfit and after a course of treatment with the lime and sulphur solution the trees were rendered free from the

SCURFY SCALE.

pest. At the present time a change of administration has taken place and the spray pump is rusting in the basement while the scale again waxes fat on the shade trees. There is another chance for the quack tree doctor.

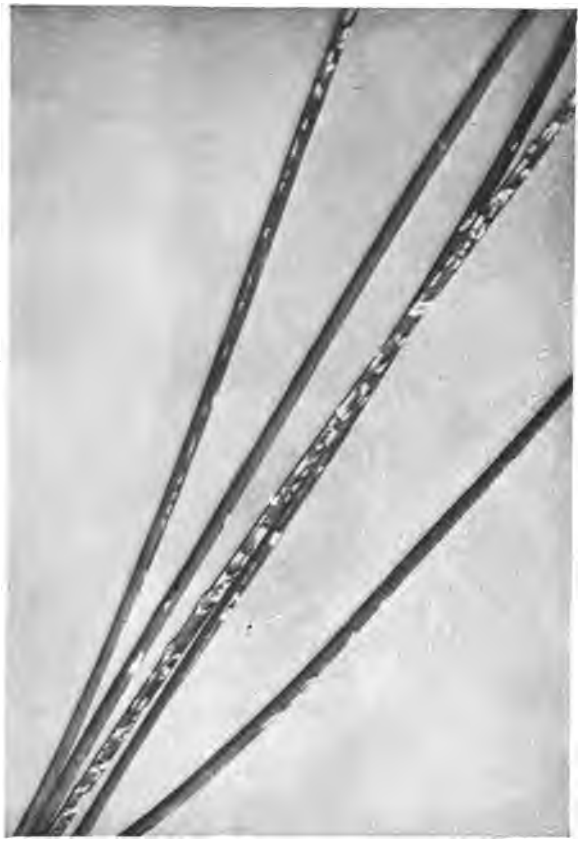
1045. *Chionaspis corni* (Cooley).

This scale was found on Cornus alternifolia in the northern part of the State. It is of no economic importance.

1055. *Chionaspis furfura* (Fitch).

SCURFY SCALE.

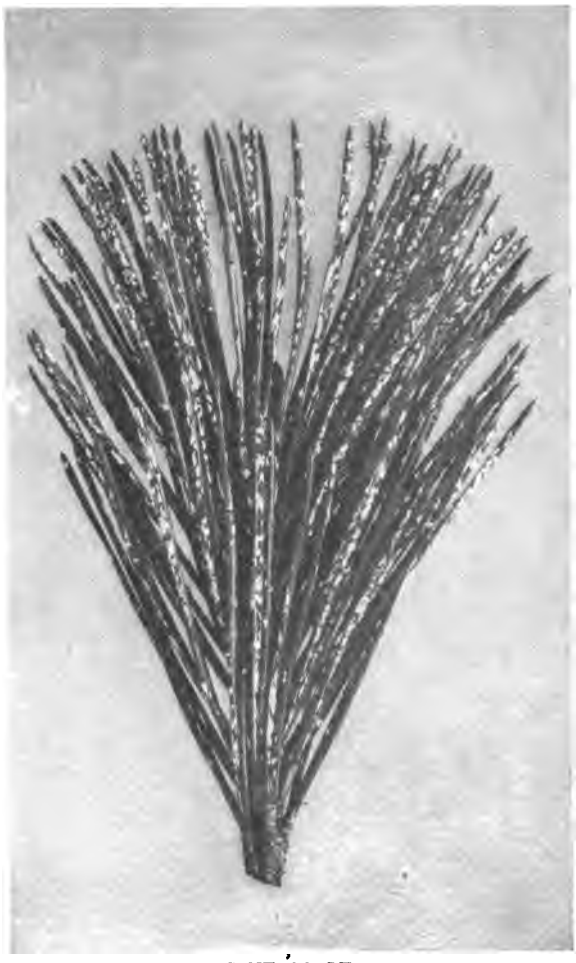
This is probably the most common scale insect in Indiana. It can be found in any apple orchard, although it does not often do any considerable damage. It is noticed on the twigs as small white blotches about an eighth of an inch in length. The male scales are smaller and usually of a brighter white. The males also



PINE SCALE

differ in shape as is shown in the cut. The insect passes the winter in the egg state under the protective scale of the old female. For this reason it is not an easy insect to control. The insecticide employed must not only penetrate the scale covering but must be strong enough to destroy the somewhat resistant eggs. The lime-

sulphur solution is only fairly successful in this regard and it is probable that the miscible oils will be found to be the best destroyers of this class of insects. It must always be remembered that the oil solutions are liable to cause a permanent injury to the tree that may be greater than the injury of the scale itself. The



PINE SCALE.

eggs of the scurfy scale are a reddish purple in color and when the insect is crushed the substance of these eggs is exuded as a reddish juice.

Fumigation will have no effect on the insect during the dormant period so that the hydrocyanic acid gas treatment of nursery stock is no protection against this scale.

1073. *Chionaspis pinifoliae* (Fitch).

PINE SCALE.

This scurfy scale of the pine is common on various conifers but is especially common on white pine. With the accompanying figures no description is needed as the scale could not be confused with any other form.

WILLOW SCALE.

Owing to the possible injury to the foliage it is impossible to employ strong insecticides against this pest. I have always advised the use of whale oil soap, to be applied early in the spring. Good results generally follow a thorough use of this material.

SCURFY SCALE OF THE WILLOW.
Showing some of the scales removed to show the eggs in winter. (Enlarged.)

WILLOW SCALE. (Enlarged.)

1082. *Chionaspis salicis-nigrae* (Walsh.).

WILLOW SCALE.

This bright white scale is sometimes found on the native willows in various parts of the State. It resembles the common scurfy scale but is much whiter. The life history is similar to the common scurfy scale and the accompanying pictures of the scales opened to show the winter egg masses would serve equally well for either species.

1127. *Aulacaspis rosae* (Bouche).

ROSE SCALE.

The rose scale is common on rose, raspberry and blackberry plants. It seldom bothers well cared for plantations, but often forms a crust on the stems of neglected plants. The individual female scales are nearly circular in outline and are loosely attached to the twig. The insect passes the winter as an immature individual and is readily killed by fumigation. I know of one case where the canes in a raspberry patch were completely crusted over, but the year following no traces of the scale were to be found. The careful grower will not depend on the parasites to keep this or any other insect in check but will employ prompt measures of eradication. In this case the lime and sulphur will be found to be entirely satisfactory.

1143. *Hemichionaspis aspidistrae* Sign.

This scale is reported from one locality—an Indianapolis greenhouse, where it was doing no damage.

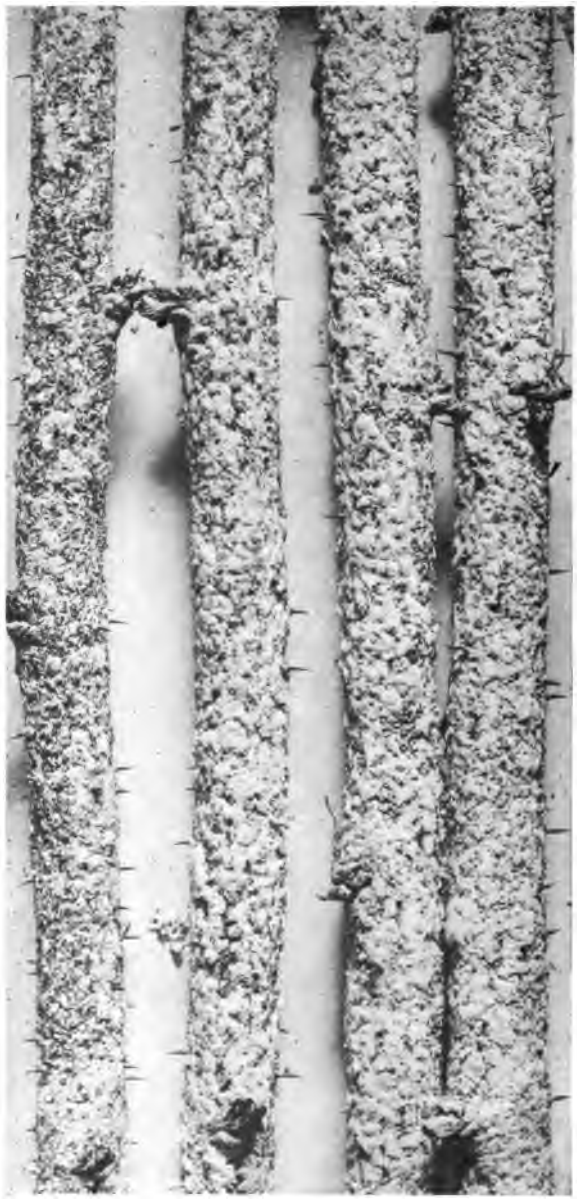
1200. *Aspidiotus ancylus* Put.

PUTNAM SCALE.

This scale is an important pest on many varieties of both shade and fruit trees. It is a close relative of the San Jose scale and resembles that insect to a considerable extent—indeed the inexperienced entomologist is extremely likely to get the two forms confused.

The mature female insect is orange yellow in color and is protected by an almost circular plate or scale which entirely covers the body. This plate appears, under a slight magnification, to be

ROSE SCALE ON RASPBERRY.



ROSE SCALE.

ROSE SCALE.

BARK FROM HICKORY BADLY INFESTED WITH PUTNAM SCALE

PUTNAM SCALE. (Enlarged.)

PUTNAM SCALE. (Enlarged.)

composed of a series of rings rising to a nipple-shaped cone. These rings are eccentric in their arrangement whereas the rings on the San Jose scale are concentric. The center of the cone is often, although not always, bright orange in color.

The scale passes the winter as a more or less mature female,

PUTNAM SCALE ON HICKORY.

most if not all of the males perish in the winter. There is but one brood of young each year, but owing to the fact that the winter is passed in a more or less complete stage of development, the young appear continually throughout the season.

PUTNAM SCALE. (Enlarged.)

The scale sometimes attacks nursery stock, especially soft maple and linden. It is then subject to fumigation the same as the San Jose scale.

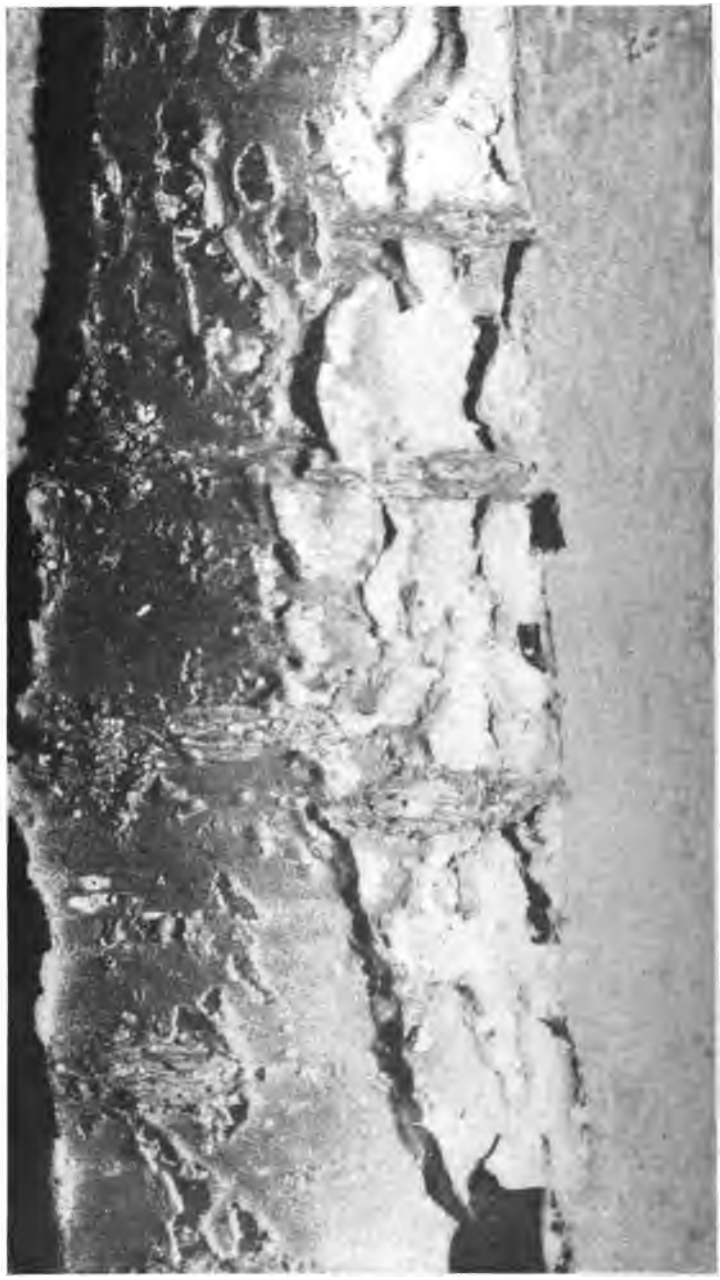
1229. *Aspidiotus forbesi* Johnson.

CHERRY SCALE.

This relative of the San Jose scale is fairly common over the State on sour cherry. Most reports of San Jose on cherry are found to be not San Jose scale at all but this native scale.

ASPIDIOTUS HEDERAE. (Enlarged.)

The individual insects have the habit of locating themselves under the loose bark on the tree. The scales are flatter, lighter in color and not so concentric as the San Jose scale.



CHERRY SCALE. (Enlarged.)

1233. *Aspidiotus hederae* (Vall.).

OLEANDER SCALE.

This scale is reported as injuring a number of greenhouse plants in the north, and many varieties of plants in the tropics.

CHERRY SCALE. (Enlarged.)

It can not live out of doors in our northern winters. It is most commonly reported on English ivy and it is on that plant that I found the single specimen I have to record.

The scales are white in color with a more or less distinct yellow center. They are nearly circular except in cases where the individuals have been distorted by crowding.

Like many other greenhouse scales, these insects breed throughout the year and if neglected they may cause considerable damage. Infested plants should be fumigated or sprayed with whale oil soap at the rate of one pound to four gallons of water.

1239. *Aspidiotus juglans-regiae* Comst.

ENGLISH WALNUT SCALE.

This important scale insect belongs to the same genus that the San Jose scale belongs to and it resembles that scale to a great degree. The scale is a serious pest on shade trees in the city of Indianapolis and is doubtless to be found in other parts of the State.

It is quite common on hard maples and linden. The scales sometimes cover the trunk and branches of the infested trees and they are to be controlled the same way that we control the San Jose scale. The insect has but one brood each year and for that reason it does not spread as rapidly as does the San Jose scale.

1256. *Aspidiotus pernicious* Comst.

SAN JOSE SCALE.

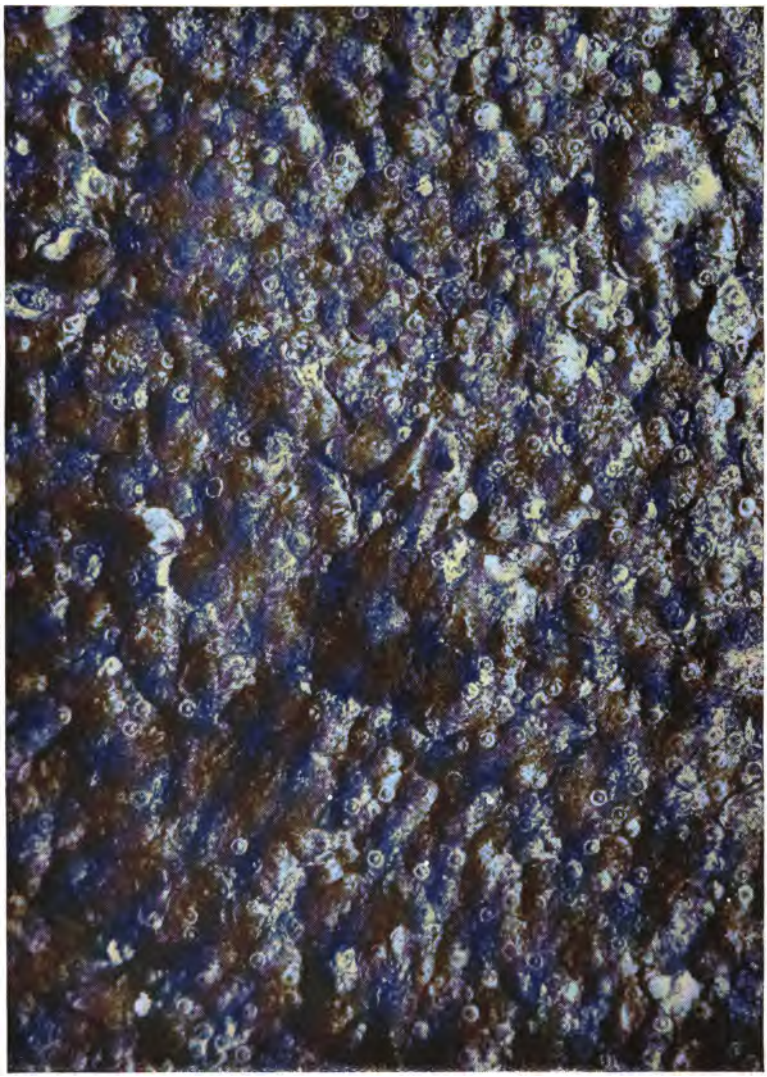
It is probable that this insect has done more to bring the subject of entomology into the public eye than any other form to be found in America. In this respect the San Jose scale has done a great public service in the way of awakening the public to the danger that confronts America in the way of injurious insects from abroad. The San Jose scale was introduced into America more than thirty years ago on nursery stock that was imported from China. The scale first became established in California and was described by Professor Comstock at San Jose. It is from this town that the insect got its common name.

Eastern nurseries carried the pest across the continent and it became established in New Jersey. The first record of the pest in Indiana is in 1893, when Mr. Edgar M. Wood of Madison found a peculiar condition on some Seckle pear trees that he had purchased from J. L. Lovett of Little Silver, N. J. These trees were submitted to Professor Slingerland of Cornell, who confirmed Mr. Wood's identification of the pest. These first trees were dug and

ORCHARD KILLED BY SAN JOSE SCALE.

HEDGES INFESTED WITH SAN JOSE SCALE THAT HAVE BEEN CUT AND BURNED.

burned, but the next year Mr. Wood found more scale on other varieties of pear obtained in the same lot with those he had burned. It is probable that all of the trees planted at that time



SURFACE CRUSTED WITH SAN JOSE SCALE.

were more or less infested, and during the summer of 1894 the insects had an opportunity to increase and spread. At about the same time (1894) the scale was found on adjoining farms on peach trees that had come from Parry's nursery, also of Little Silver, N. J.

This early infestation at Madison has been the center from which the scale has spread in all directions, until it now covers that entire section.

FEMALE SAN JOSE SCALE WITH YOUNG.

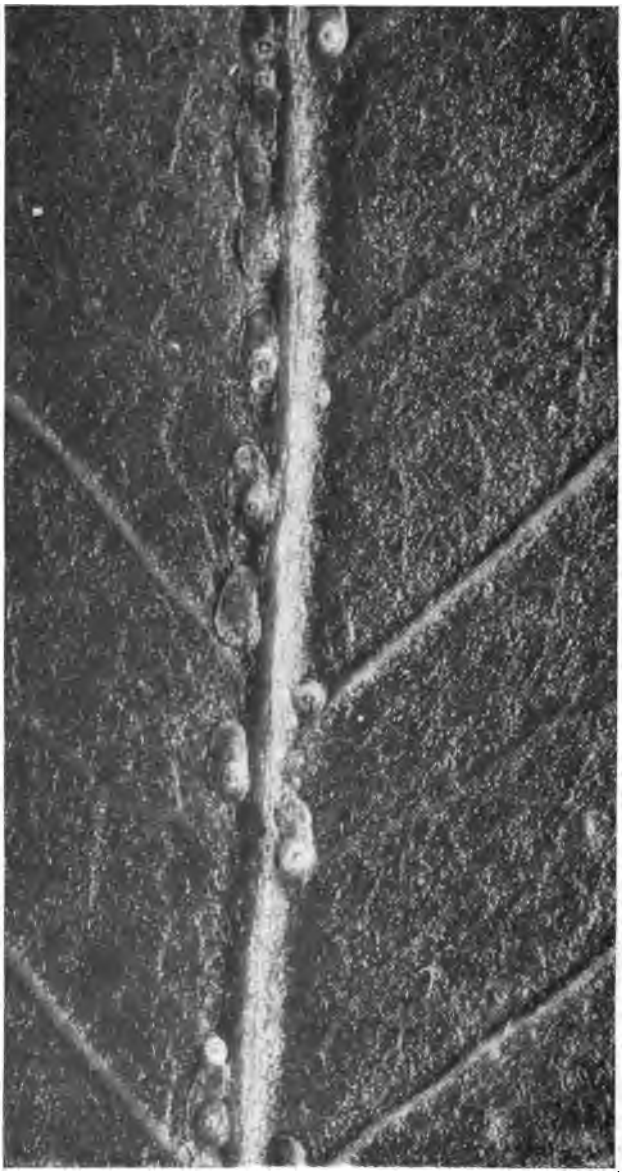
In 1896, Professor Webster of the United States Department of Agriculture, found the scale on pear trees in Ben Davis. These trees also came from the Parry nursery at Little Silver, N. J.

It has been stated by a prominent nurseryman that most of the scale shipped into Indiana on nursery stock came from a firm located at Dayton, Ohio. From this central point of infestation

SAN JOSE SCALE. FEMALE WITH YOUNG.

the pest was sent all over this State and soon the local nurseries became infested and did their part in distributing scale to the farmers.

Life History.—The San Jose scale begins life as a minute sulphur yellow insect that is capable of crawling about on the surface of the plant on which its parent is attached. After a period of



MALE SAN JOSE SCALES ON LEAF.

about twenty-four hours the young scale settles down and attaches itself to the surface tissues of the plant that it happens to be on. Its feeding beak or proboscis is inserted through the bark and it obtains its food by sucking the juices from the plant. In a short time, varying some with the season, the young insect secretes a covering of white wax. This little covering is the beginning of what is to become the "scale" covering or shield that protects the soft body of the insect during the rest of its growing existence. This plate or scale is secreted in rings as the insect grows inside and ultimately it forms a plate about one-sixteenth of an inch in diameter. The rings that form this plate are concentric and in the center is a slightly raised place, giving the scale its characteristic crater-shaped form. The male scales are slightly elongated in order to accommodate the developing wings of the adult male. The males only are winged, for the females remain attached to the host plant throughout their existence. A badly infested tree will have the bark so covered with the scale that no normal plant tissue can be seen—the entire surface is simply crusted. The male scales often attach to the leaves of plants, and practically all of them die in the winter.

The females pass the winter in various stages of development. There are many generations each year and the active scales will be found quite late in the fall. I have found them in northern Indiana late in November, and in mild seasons they may continue to breed even later than this.

The principal measure practiced on the San Jose scale is winter spraying with the lime-sulphur solution. This is simply a solution of lime and sulphur made by boiling 50 pounds of each in 150 gallons of water for about an hour. This preparation will kill every scale with which it comes in contact. Failures with it are due to the fact that it is not properly made or that it is poorly applied. A tree that is sprayed for any scale insect must be thoroughly soaked with the solution. The tree must be just as wet as if it had been taken up by the roots and dipped into a tank containing the mixture. If the tree is sprayed from only one side the scales on the protected side will live to reinfest the entire tree early in the summer.

The commercial lime and sulphur preparations are fully equal to the home-made solutions, and can be substituted for it. The so-called miscible oils are not recommended, owing to the fact that when they are used strong enough to kill the scale they also prove injurious to the tree.

Where nurseries are found infested with the San Jose or any other scale insect that winters in any but the egg stage we require that all stock sold be fumigated. This fumigation consists of ex-

ASPIDIOTUS RAPAX.

posing the stock to the vapor of hydrocyanic acid gas for forty-five minutes. The question of fumigation is of especial interest only to nurserymen and it has been fully covered in my first annual report.

1261. *Aspidiotus rapax* Comst.

The female scales of this species resemble the San Jose scale very closely. They differ in that the scale covering is less flattened and the color is lighter. As in the Putnam scale, the yellow insect sometimes shows through the apex of the scale covering.

The species is confined to greenhouse plants and is reported from only one locality in Indianapolis, where it was found by Mr. Morrison. The specimens found were on laurel and were doing considerable damage. Isolated cases of this sort can probably best be handled by destroying the plants on which they occur.

1272. *Aspidiotus uvae* Comst.

GRAPE SCALE.

This interesting and important scale was found on grapes at Vincennes, Indianapolis, and in Harrison County. It is by far the most important scale insect affecting the grape and can not be readily mistaken for any other form.

The scales, which are similar to the San Jose scale, sometimes completely cover the canes, and plants are often killed by them.

The accompanying cuts fully illustrate the pest, and further description is not necessary. They can be controlled by the use of the lime and sulphur solution in the winter time.

1294. *Chrysomphalus aonidum* (Linn.).

CIRCULAR SCALE.

This is a pest of greenhouses and is not established in the open anywhere in the State to my knowledge.

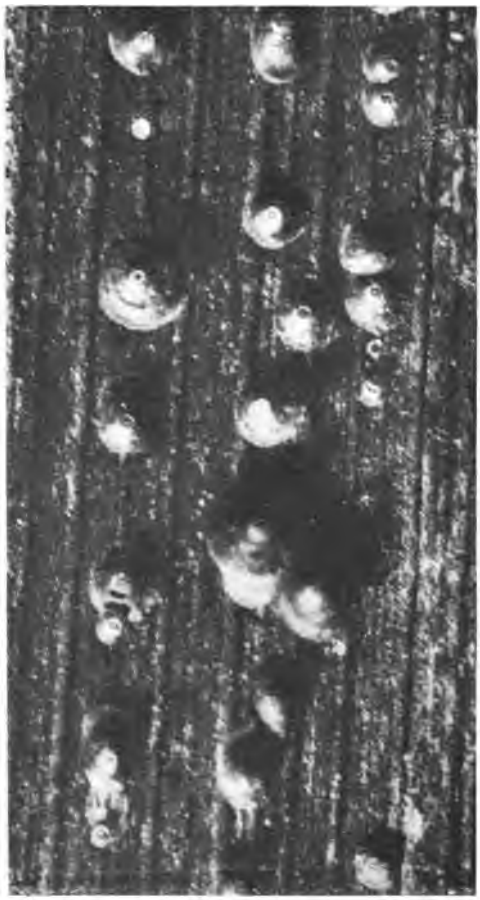
The scale is dark in color and is almost entirely circular, resembling the San Jose in this regard, but it is much smoother than the San Jose scale. The surface of the scale is a shining dark brown, although there is some of the concentric ring appearance which is so characteristic of the San Jose. It is well shown in the accompanying cuts. Palms and ficus seem to be especially subject to its attack.

GRAPE SCALE.

GRAPE SCALE. (Enlarged.)

CIRCULAR SCALE. (Natural size.

CIRCULAR SCALE ON FICUS.



CIRCULAR SCALE. (Enlarged.)

CIRCULAR SCALE. (Enlarged.)

1300. *Chrysomphalus dictyospermi* Morg.

MORGAN SCALE.

This scale is very similar to the circular scale except that the individuals are lighter in color and are flatter. It is a greenhouse pest of rather uncommon occurrence.

MORGAN SCALE.

MORGAN SCALE. (Enlarged.)

1377. *Lepidosaphes becki* (Newm.).

PURPLE SCALE.

This is one of the most important scale insects of the citrus fruit districts and is often sent into Indiana on oranges and lemons. It resembles the common oyster shell scale that we have in Indiana.

PURPLE SCALE. (Enlarged.)

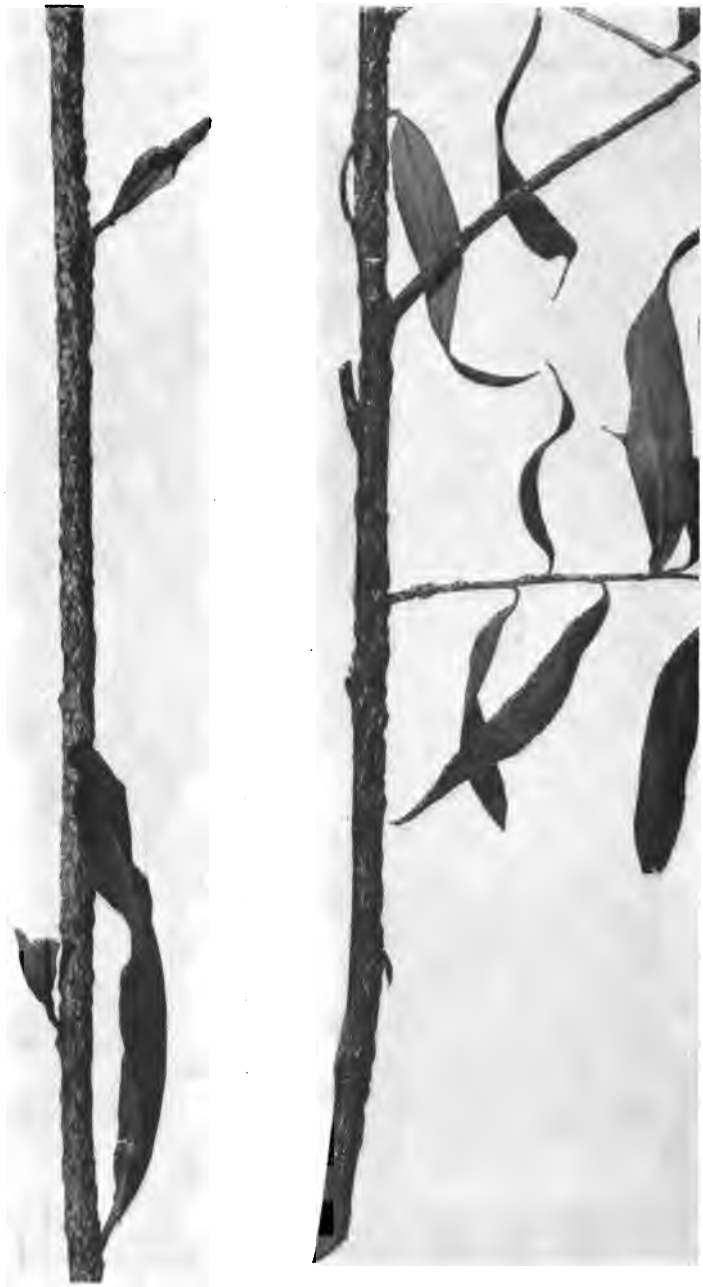
Sent into Indiana on citrus fruits. This form is not to be feared as it would not survive our winters.

1431. *Lepidosaphes ulmi* (Linn.).

OYSTER-SHELL SCALE.

This common and destructive scale is one of the most important pests with which we have to deal in this State. It attacks many varieties of plants and is especially injurious on apple,

OYSTER SHELL SCALE.



OYSTER SHELL SCALE ON WILLOW.

maple, poplar and willow. It is also a very common pest on lilac bushes.

The cuts show the scales so well that an extended description is not needed. The scale winters in the egg stage under the shell

OYSTER SHELL SCALE. (Enlarged.)

of the parent scale. These eggs are white in color and oval in shape. There will be from fifty to one hundred under each old scale. In this way the insect is doubly protected by being in the egg stage and by having these eggs covered with the old scale. The eggs hatch in spring, generally during the month of May,

and it is at this time that the young scales can most easily be controlled. A coal oil emulsion can be applied while the scales are still young and a majority of them will be killed. The only ob-

A SOFT SCALE ON HICKORY THAT SEEMS TO BE NEW TO SCIENCE.

jection to this treatment is that the leaves are already on the trees and for this reason thorough work can not be done. The full strength lime and sulphur applied during the dormant season has not given entire satisfaction, but I believe that if two appli-

cations are made, one in the fall and one in the spring, the insect will be controlled absolutely. I do not favor the use of any oil spray on trees, as it is often attended with injurious results.

The fact that the insect winters in the egg stage makes it a very hard one to deal with in the nursery. It can not be killed by the use of hydrocyanic acid gas, and as a result any infested trees must be destroyed. The planter of apple stock should be very particular to examine his tree to make sure that this scale is not present.

The scales have but one brood each year throughout Indiana. It is more often met with in the central and northern counties than in the south, although I have found it in almost every county in the State.

NOTE ON A NEW SPECIES.

In August, 1911, I was collecting with my assistant, Mr. Harold Morrison, in Brown County, and on shell-bark hickory trees we found what appears to be a new species of scale insect.

A few adult females were found under flakes of bark. At that time they were bringing forth living young in considerable numbers. The young showed a tendency to gather in clusters, as shown in the accompanying photograph, which was made in the laboratory a few days later.

The adults were about 2.5 mm. in length. Antennæ eight jointed. Body clearly segmented pink or flesh color and more or less covered with a white waxy secretion.

Specimens were sent to Dr. L. O. Howard, at Washington, and to Professor R. W. Doan of Stanford University, but so far the species remains unidentified. It may be that additional material will show this to be a distinct species. Next season's work will be necessary in order to determine this point.

MISCELLANEOUS INSECT NOTES.

Periodical Cicada.—The 13-year brood of the Periodical Cicada was due to occur in several counties in southern Indiana the past season. After a diligent inquiry, I have been able to find but two records of the occurrence of the Cicada this season. One of these records is by Mr. Charles C. Deam, the secretary of the State Board of Forestry, who reported the insect near Goose Pond, in Posey County. The other record is from Mr. W. C. Reed of Vincennes, who states that the Cicadas were exceedingly numerous in the vicinity of his nursery in May, but, while they appeared in large numbers they remained only a very few days. A severe storm of May 30th seemed to destroy a large portion of this brood, and it is reported that after the storm practically no Cicadas were to be found. No injury was reported in either case.

Several other reports to the effect that the Cicadas appeared in various places were investigated and in each case it was found that the insects referred to were not the thirteenth- or seventeenth-year species, but the two-year Cicada. This two-year form seems to have appeared in unusual numbers in quite a number of places in Indiana during the past season. The thirteen-year brood is the one known to entomologists as brood 23, and it has been facetiously claimed by some entomologists that this number which has been applied to it has something to do with the nonappearance of the brood in many localities where it was expected this season.

Strawberry Leaf Rollers (Pacoetia obsoletana).—This insect was unusually prevalent in many localities this season. In one or two cases I had to refuse to issue certificates to strawberry growers whose patches were severely infested with this pest. There is absolutely no excuse for a careful grower allowing his berry patches to become badly infested with this insect. The adult moth lays the egg on the leaf of the strawberry and the young caterpillars eat the surface and fold the leaves over them for protective covering. The cocoons are finally spun within these rolled leaves. Some patches that I have seen had practically every leaf either eaten or rolled with a larva on the inside of the rolled leaf.

An early application of any of the common insecticides, such as Paris green or arsenate of lead, preferably arsenate of lead,

would result in the complete eradication of this pest, or the excellent practice of burning over the strawberry patch after they have fruited would destroy thousands of them and hold the insect completely in check. I can see no reason for the intelligent strawberry growers failing to take these precautions.

The practice of burning the beds over is an especially valuable one, for it not only controls this particular pest, but will destroy many other leaf-eating insects and will do a great deal in the way of controlling the strawberry leaf blight which, in some sections, is in itself quite a barrier to the successful growing of this profitable fruit.

The Wheat-Stem Maggot (Meromyza amercana Fitch).—During the past season, this pest of the wheat was reported from several localities in the northern part of the State. In some instances, the work of this insect was confused with the work of the more common and more injurious insect, the Hessian Fly. The larva of the insect burrows in the stalk of the grain and causes the head of the grain to turn white and they fail to fill out. The wheat-stem maggot is a native insect and naturally occurs on various species of native grass. It has adopted the wheat since agriculture was introduced into America, and in some seasons is quite injurious. Like nearly all of our native insects, this pest is controlled by parasites and, as a rule, does not occur in injurious numbers two seasons in succession. Owing to the fact that the insect lives on native grass it is more difficult to control than the Hessian Fly, which can be perfectly controlled by trap crops, as suggested elsewhere in this report.

Investigations in the West indicate, however, that the wheat which is planted in October is less liable to injury from this pest than the wheat planted earlier in the fall. This is in line with the same practice regarding the control of the Hessian Fly. The following life history of the insect is taken from Professor Lawrence Bruner's account.

"The adult is a small, greenish fly, marked on the thorax and abdomen with three black stripes. It raises three broods a year, passing the winter as a larva in the winter wheat, transforming into the pupa in the following spring and immediately thereafter, in latter May and early June, issuing adults of the first brood, which may reattack the same plants or spread to other fields or grasses. The female oviposit upon the young growing stems at the edge of or beneath the sheath-like upper leaves. The eggs are very small, white, elongated, with pointed ends, and plainly ridged

lengthwise. The larvae, which soon hatch from them, are also small and slender, about a quarter of an inch long when full grown, with the head end pointed and the other obtuse, in color greenish white. They work their way to a point just above the upper joint, where they enter the stem, tearing the tissues with a pair of black hooks situated near the sucking mouth, and feeding upon the plant juices. The ravages of the growing maggot cause the unfilled head and upper joint of the wheat to die and turn white, while the rest of the plant continues alive and green. These larvae mature by the middle of June, pupate, and the adults of the second brood appear in July. This brood is reared on volunteer grain or wild grasses, and brings forth its adults in September and October. This third brood attacks the winter wheat and remains therein until spring. The effect of the larvae upon the winter wheat is to cause the central tubular leaf of the infested plant to shrivel and die, turning yellow, the larva being located within the stem just above the root."

The Hessian Fly (Cecidomyia destructor Say).—During the past season the Hessian Fly has been unusually destructive in the wheat fields of certain portions of northern Indiana. In some fields which I have observed the extent of the injury was so great that the grain was scarcely worth the cutting. It is probable that the dry weather of the early summer has served to some extent in reducing the numbers of these insects and may possibly be an important factor in their control for the next year. In badly infested districts, the farmers should adopt preventive measures against this insect. It is one that yields very readily to preventive work, and unless some measures are adopted to check its progress it will cause thousands of dollars worth of damage. There are three factors which enter into the control of the Hessian Fly.

The first of these consists in the burning of the stubble fields after the wheat harvest, and ordinarily it is advisable to do this just as early in the summer as possible. During a dry season the flies may remain in the stubble for a long period, but with occasional rains their emergence may be hastened and they may leave the stubble before the burning has accomplished its purpose. Early burning is also advisable for the control of several other injurious wheat infesting insects.

The second factor in the control of this pest consists in planting what we know as trap crops. This simply consists of a few rows of wheat planted around the proposed wheat field late in the summer. This trap crop should be planted not later than the

last week of August and should be plowed under about four of five weeks later.

Third factor in the control of the fly is to see that the wheat is planted just as late in the fall as possible. In this way, the insects are forced to lay their eggs on volunteer wheat and possibly on other grasses and the main crop will be saved. Some farmers hesitate to employ the method of a trap crop, owing to the fact that their neighbors will not co-operate with them. They fear that they will have all the labor and expense of the work and that their neighbors' infested fields will serve to reinfest theirs the following spring. While there is some room for argument of this question, it has been demonstrated beyond a doubt that the farmer who applies the trap crop will be far better protected from the Hessian Fly than will his neighbor who does nothing at all to prevent the injury. This is due to the fact that the Hessian Fly will not leave the parent field at the spring of the year but will reinfest the wheat in the immediate vicinity where it is hatched. It is true that the insects are sometimes blown by the wind for a very considerable distance and in this way they may reinfest a field a long ways from the field in which they were originally hatched. Like all preventive insect work, it is well for all the farmers in one section to work together and co-operate in the control of a pest of this sort. A co-operative work in a community will be of vast importance to the members of that community, provided they can all work together in harmony and can plan their work to advantage. The following detailed life history is from Professor Lawrence Bruner's excellent account of the insects:

"The adult flies of the fall brood begin to issue during the last days of August or early in September, and shortly after emergence and subsequent fertilization, the females fly to the young wheat plants and deposit their eggs in regular rows of one to a dozen or so along the depressions of the veins on the upper surface of the wheat blade, somewhere between the tip and the junction with the stem. These eggs are very small, about one-fiftieth of an inch in length, cylindrical, with rounded ends and of a glossy reddish color. A single female may lay as many as a hundred or even two hundred or more eggs. The adult flies are very short lived, and after the duties of reproduction are accomplished they usually die within a few hours, three or four days constituting the usual lease of life.

"In three to five days, according to condition, these eggs

hatch, and the little larva, scarcely larger than the egg from which it has developed, migrates down the blade and between the sheath and the stem until it reaches a point near the root, at about the level of the outside soil. Here it remains stationary, gaining nutrition by absorption of the plant juices, its mouth being too weak for gnawing, and causing a gall-like enlargement or swelling at the point of attack. Growth proceeds rapidly, and in about three weeks the larva is full sized, and may be described as a thirteen segmented, semi-transparent, flattened ovate maggot, measuring about one by three millimeters.

"It is during this growing larval period that the harm is done. The main stem being the most developed, it is generally the one upon which the majority of the eggs are deposited, and accordingly, is usually the first to show attack. The immediate effect is often to produce an abnormally dark green color which gives the plants temporarily a very thrifty appearance. This, however, gives way to a brownish, then a yellowish color, and finally the blade shrivels and dies. When sufficient moisture is present and the plant is not too badly infested, it sends out lateral tillers abundantly, and these often develop into strong stalks, thus making possible a partial crop if the spring brood is successfully overcome. Infested plants may be recognized by their darker color, more bunchy appearance, lack of stem, shorter, broader, and more upright blades, and the lack of the tubular young central leaf, this failing to develop.

"Once full grown, the larva contracts, leaving its outer skin to form a hard brown shell or puparium, which is commonly known as the 'flaxseed,' and this stage is called the 'flaxseed stage.' It is in this stage that the insect passes the winter, safely imbedded among the roots of the wheat, and any condition which would be severe enough to destroy it would destroy the plant as well. While enclosed within this 'flaxseed' or larval skin, the insect turns from its head downward position which has been maintained since its first ingress, to one in which the head is directed upward. In accomplishing this turning movement the 'breastbone' or sternal spatula, a small, forked process on the ventral surface between the first and second segments, is used to advantage by the larva. It then completes the transformation into the pupa.

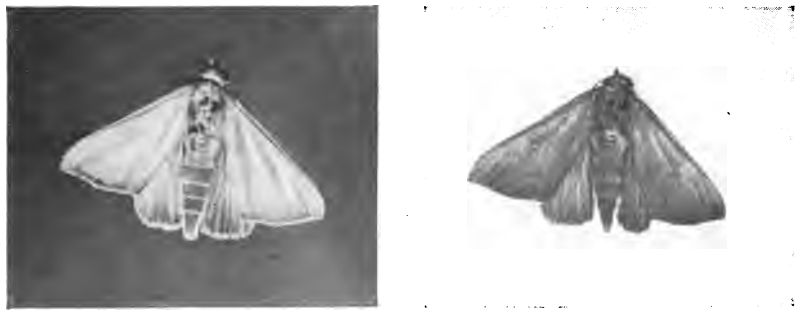
"*The Spring Brood.* During the winter the main stems partially decay and are either matted to, or in part covered by earth, or else entirely concealed by the fresh and uninfested green tillers, so that fields which easily revealed an abundance of 'flaxseed' in

the preceding fall, in the spring show them only after careful search, hence it is often supposed that the flies have been in some way destroyed. Needless to say, this condition is only apparent. About the first week in April the flies begin to emerge in southeastern Nebraska and continue to do so gradually more northward and westward until the whole of their range is covered. They do not all emerge at once, but gradually increase in numbers, reaching their maximum about two weeks after the date of first emergence, and the last ones do not appear until the first week of May or possibly even later. The males always emerge first and greatly predominate in numbers for the first day or two, after which the females begin to appear in force.

"In emerging, the pupa simply forces off the upper end of the 'flaxseed' and makes its way out, pushing along under the enveloping sheath or biting through it with its hardened jaws until it is exposed. At first its color is pure white, but later this changes to a pinkish. Having found a point of egress, the thin pupal skin splits and the adult fly laboriously extricates itself. As a rule the fly does not travel far in the spring brood, but tends to reattack the plants in the same field from which it has emerged."

The Cotton Worm Moth. (Alabama argillacea.) This interesting insect is a pest of the cotton fields of the South, and it is a rare occasion when it advances to our colder Northern clime.

During the month of October large numbers of these moths



COTTON WORM MOTHS.

migrated north over Indiana, and at night they were to be found around the electric lights in almost any of our cities. In Indianapolis they occurred in such large numbers that the pavements under the lights were covered with their bodies every morning. I found them as far north as Muncie, where they were fairly common.

Many fruit growers reported that they were to be found in the orchards feeding on over-ripe peaches and other soft fruits. During the day they rested in sheltered places and were very common in the grass and among fallen leaves.

The moth is a peculiar tawny color and when at rest carries its wings folded as in the accompanying cut.

ADULT OF THE COTTON WORM.

Of course all of the moths that reached this far north will perish in the winter cold and none of them will be able to carry the race over to next year. It is obvious that a moth that appears with us only in the adult stage can be of no economic importance, as it feeds but little and then only on the juices of broken and decaying fruit.

BEE KEEPING.

This ancient form of husbandry is a source of pleasure and profit to thousands of people all over Indiana, and it has been my privilege to visit many apiaries, large and small. The more I see of bee keeping the more enthusiastic I become about it and the gladder I am that I keep bees myself.

A SMALL HOME APIARY KEPT AS AN INTERESTING PHASE OF NATURE STUDY

I started as a beekeeper by purchasing a few colonies in old box hives, which I transferred to new frame hives. Bees in box hives can often be bought for a low price, and this is often a good way for the beginner to get a start. It has the one objection that the amateur apiarist is at once confronted with one of the most serious problems of bee keeping, namely, transferring. In a sense, this is a good thing, for it certainly affords an unequaled opportunity for the bees and the beekeeper to become intimately acquainted—a thing that is of more importance than may be supposed by the novice who reads these pages.

OPENING AN OLD NEGLECTED HIVE.
Use plenty of smoke as the neglected bees are liable to be cross.

THE SIMPLEST FORM OF TRANSFERRING.

The frames are lifted from the old and rotten hive bodys into the new clean hives.

It is a well-known fact that bees become acquainted with people that are frequently around them and that occasionally handle them. For this reason, some of the old-time beekeepers in nearly every locality have earned the reputation of being "bee men," men who are especially adapted for handling bees. As a matter of fact, almost anyone can become a "bee man" if he chooses to do so. The principal thing required is a certain amount of self-confidence in handling the bees, and also a certain amount of indifference to stings. The novice who starts to handle bees can expect to be stung frequently, but after one season's work in the apiary he will find that the stings are much less frequent than they were at first. This is due, probably, to a certain ease with which the beekeeper learns to handle his bees and to a certainty which he acquires in manipulating the hives. Any uncertainty on the part of the operator is quickly noticed by the bees and they at once take advantage of it to attack whom they regard as an intruder. For the benefit of the beginner who may perhaps buy his bees, as I did to start with, in old box hives or crude home-made hives of some sort, I will give a brief account of the methods employed in transferring the bees from such hives into new, modern hives.

TRANSFERRING.

The new hive should be placed in the exact position of the old hive, which has been set aside for the purpose. Thoroughly smoke the bees at the entrance of the old hive, and if it is a box which can be opened without any great difficulty, the lid should be pryed off and the bees thoroughly smoked from above. Give them a few minutes in which to fill up with honey, as this makes them very much easier to handle.

In case the old hive is what is called a box hive and does not have movable frames it will be necessary to cut out the brood combs and fit them carefully in the frames in the new hive. After removing a single brood comb from the old hive it should be carefully brushed to remove any adhering bees and then should be laid on a soft pad of old cloth. In this way the young brood will not be injured.

Now lay one of the new frames from the new hive down on the brood comb and carefuly cut the comb so as to fit the frame just as nearly as possible. After fitting the comb into the frame a piece of ordinary cotton twine should be wrapped around the frame so as to hold the comb in place. In case a close fit has been

made it may not be necessary to do this. The frame is now ready to be placed in the new hive. Each comb should be dealt with in the same manner, and in case there are not enough combs to fill all of the frames in the hive the remaining frames should be filled with whole sheets of foundation and be placed alongside of the frames containing the brood combs.

In case this work is done early in the spring all of the brood combs should be placed in the new hive close together, but if it is done later in the year, after the weather is warm, it is a good idea to place the frames containing the foundation between the frames containing the brood combs. In this way they will be built up quicker and a little more uniformly.

Care should be exercised to see that the old queen is caught and placed in the new hive. In case the old hive is a home-made box hive this is not always easily done. Very often the queen will retire to some secluded portion of the box and hide in a crack or corner and be rather difficult to find. In such a case the queen must be picked up with the fingers and placed on one of the new brood combs.

There is some difference of opinion as to the best season of the year for transferring bees. As a rule the work should be done as early in the season as possible, for at that time of the year there are fewer bees in the hive and they more readily accept new conditions, in addition to being much more easily handled. Perhaps the best time of year for this work is during the period of the fruit bloom in the spring, for at this season the bees are few in numbers and are energetically at work gathering nectar from the fruit bloom. The fact that they are getting something from the field will prevent robbing, which would undoubtedly occur if the transferring was attempted during a season when there was no honey flow of any sort.

In case it is necessary to transfer the bees during a season of no honey flow it will be well to carry on the work under some sort of screen or shelter. A tent is manufactured from mosquito netting that is very convenient for this work and it costs but little. A homemade tent would, of course, answer fully as well.

All fragments of old comb should be gathered up and rendered into wax immediately. No rubbish of this sort should be permitted to remain around the beeyard, as it will very often lead to the bees contracting the robbing habit, and as a result the bees will be cross throughout the season. The old hives can often be used advantageously as hive stands for the new hives; though, if

they are in a very badly dilapidated condition, probably the best disposition which can be made of them is to use them for kindling wood or burn them on the spot.

Somestimes it is possible to buy bees in old hives that contain standard frames. In such cases it is only necessary to lift the frames out of the old boxes and place them in the new hive bodies. In this way all cutting of frames and any loss of brood or honey

A NEGLECTED APIARY.

is avoided. The entire operation is rendered very much simpler and the bees are not disturbed any more than they would be in a casual examination of the brood chamber later in the season.

The same precautions, however, are to be used in securing the queen, because the queen in a colony that is not accustomed to being examined is often very shy and inclined to hide at the first disturbance.

STARTING A NEW APIARY.

After having successfully kept a few colonies of bees I decided to branch out as a more extensive apiculturist. I studied the advertisements in the bee-keeping journals and in the local papers and learned of a number of apiaries that were for sale at various

prices. I finally located three beeyards of various sizes—one located at Terre Haute, Ind.; another at Ben Davis, and a third near Riverside Park, northwest of Indianapolis.

All of the bees in these beeyards were examined and found to be in an apparently healthy condition and were purchased at prices ranging from $2 per colony for the Terre Haute bees to $4 per colony for the bees at Riverside Park. The difference in price

ANOTHER VIEW OF THE NEGLECTED APIARY.
This kind of bee keeping represents a loss.

was due partly to the fact that the Terre Haute bees were of much poorer quality, the hives were all very old and dilapidated, and they also had to be transported farther than any of the others.

I found that the first problem that I had to meet was one of transportation, but I finally overcame this difficulty by chartering an interurban car to bring the bees from Terre Haute to Broad Ripple, having determined to locate the apiary about a mile north of Broad Ripple.

On a cold, raw day, early in April, I took an assistant and went to Terre Haute to prepare the bees at that place for shipment. Nearly all of the hives were in a badly dilapidated condition, very old and very rotten. In many cases the botton boards had completely rotted off and some of the hives were resting di-

rectly on the ground. In others the covers were entirely gone and the bees were protected only by scraps of wood and sheet-iron that had been laid loosely on top of the colonies. The surprise to me was that bees could exist in such dilapidated hives, but they were unquestionably in good physical condition at the time that they were bought. Owing to the character of the hives it was necessary to enclose the entire bottom with screen in most cases. Some of the hives were so badly rotted that it was necessary to nail screen over the top as well as the bottom, making both the top and bottom of open screen. There were forty-one colonies of bees in this lot and it is hard to realize the magnitude of our undertaking in preparing these colonies for shipment. I would never buy another lot of bees that were in such bad condition as was this particular apiary. The work which we had to do on the beehives and the difficulty which we had in transporting them fully made up for the small saving in the price of the bees.

I think I should say something about the manner in which these old hives were closed with screen. In the first place a sheet of wire screen cloth was cut just big enough to lay over the top of the hive and to fold down nicely on all sides, leaving a margin of about an inch. This was placed over the hive after the cover was removed or after the bottom part was removed, as the case might be, and was then secured to the hive by strips of lath nailed at the sides. The corners had to be neatly and closely folded in order to prevent the possibility of the bees getting out at the corner folds. In this particular instance the work was done during a rather cold afternoon and the bees did not cause us very much trouble. They were not flying when we started to work about 3 o'clock and made but few attempts to fly during the afternoon. We had no difficulty whatever in controlling them with the use of smoke, which we applied liberally.

We engaged a farmer living in the neighborhood to haul the bees from the apiary to the traction station and directed him to be at the apiary to move the bees at 6 o'clock. He arrived promptly, but we were forced to disappoint him, as our work was but little more than half done at that time. We were compelled to work exceedingly fast in order to complete the work, and finally closed the last colony at 8 o'clock. At that time we ceased work, owing to the fact that the supply of screen wire had run out, and we were compelled to leave three colonies of bees at the old apiary, making in all thirty-seven colonies that we brought on to Indianapolis. The three colonies that were left were afterwards traded

to the man who hauled the bees, in exchange for his labor in doing so. He had already agreed to haul the bees for $1.50, but we had kept him waiting so long and he was so patient that I did not regret letting him have the bees, although thy represented a much larger money value than he had asked for his work in hauling them. If I had not let him have them they would have been a clear loss, as we could not take them along. It would not have paid to have gone back after them on a second trip.

BEES ON BOARD CARS.

We finally got the bees to the traction freight house about 10 o'clock at night. This was, of course, after hours for receiving freight, but I had previously made arrangements with the manager of the freight house so that we had no difficulty in getting the bees into the freight shed, where they were left for the night.

Early the next morning my assistant went on to Ben Davis, where we had purchased twenty more colonies of bees. These bees were in far better condition and in better hives, so that it was not such a big job to prepare them for shipment. I stayed at Terre Haute and loaded the special car at 7 o'clock the next morning and accompanied the car on to Ben Davis, where we picked up the twenty colonies of bees that had been prepared for shipment that morning. In shipping the bees in the interurban car we

avoided all necessity for bracing the hives in the car, as there was no bumping or jolting such as the bees would get on a steam road. While I have never shipped any bees on steam cars, I understand that it is necessary to brace the hives so that there will be no shifting of the cargo when the cars are bumped in switching. The only precaution which we used in loading the cars at Terre Haute and Ben Davis was to see that the hives were placed in the car with the brood frames running the same way as the car. I doubt very much whether this precaution was necessary in this case, as the car came through so smoothly and with so little jolting that no possible injury could have occurred to the combs even if they had been swung crosswise of the car.

UNLOADING BEES FROM CAR.

Most railroad companies require that in shipping bees an attendant must accompany the shipment. This is a wise precaution and I believe should be required of all beekeepers who ship stock any distance. Even with the care which we used at Terre Haute we found that one or two colonies developed a leak during the morning and these leaks had to be stopped immediately. This was very readily accomplished by the use of a little cotton which was carried for the purpose and which was simply crowded into the crack through which the bees had found egress.

I observed one rather interesting point while riding with the bees from Terre Haute to Ben Davis. When the few bees escaped in the leak mentioned above I watched their behavior in the car

THE NEGLECTED APIARY AS IT LOOKED AFTER IT WAS MOVED TO ITS NEW LOCATION.

and was surprised to find that they had no difficulty in flying out of the car door and flying right ahead of the car. This was at a time when the car was going probably from thirty-five to forty miles per hour. This shows that the flight of the bee must considerably exceed the speed of the average train. We had no further difficulties with the bees and unloaded them uneventfully at the station at Broad Ripple. From there they were hauled to a farm about three-fourths of a mile from the station at that town. We placed them roughly in rows in the northwest corner of an apple and pear orchard and at once opened the entrance of the hives so that the bees could fly out. This was about 5 o'clock in the evening, and the bees had been confined for about twenty-four hours. They were not particularly cross, however, and we had no difficulty in opening the colonies.

By some oversight one of the colonies was not opened on the first evening, and by the same oversight it was neglected for more than a week, when I chanced to see that there were no bees flying out of that particular hive. The hive was an old box affair with the entrance located on the under side in a place that very readily escaped ordinary attention. I expected to find that the bees in this colony were in bad shape, if not dead, but to my very great surprise they behaved nicely when I opened the entrance. They were not cross, and very few of them were dead. It would be interesting to know just how long a colony of bees could be closed up without suffering some definite injury.

Twenty more colonies of bees were purchased at a point near Riverside Park and were transferred to the location of the apiary in a large farm wagon. These bees were in better hives than those bought at Ben Davis or Terre Haute and we paid more for them. They cost on an average of $4 per colony. Some of the colonies were in hives sufficiently good that they did not need to be transferred. Most of them, however, were transferred to new hives. These made a total of seventy-seven colonies located at the new apiary. All of these bees had to be transferred into new hives in preparation for the coming season. Practically all of the colonies, except a few bought at Terre Haute, were in hives containing standard size brood frames, so that the work of transferring consisted merely in lifting the frames out of the old boxes and placing them in the new hive bodies. In a few cases the colonies brought from Terre Haute were in old box hives and it was necessary to demolish the hives and cut the brood combs to fit the new frames, and this made considerable more work. For this reason

I would never again buy any considerable quantity of bees in box hives. It is also difficult to determine the condition of the bees unless they are on standard frames.

Practically all these bees, especially those brought from Terre Haute, were well supplied with stores and had gone through the winter in splendid shape. They were all raising brood at the time that they were purchased and the honey flow from the fruit bloom was unusually large. The indications were for a splendid season

PLANT LICE, THE SOURCE OF HONEY DEW.

and the bees were encouraged to build up as strong colonies as possible. It so happened, however, that the weather was unfavorable for the beekeepers during this past season, and our entire prospects were blasted by the extreme hot weather which started at the beginning of the honey flow on the white clover. I never knew the bees to be in such strong condition as they were at the beginning of the clover flow this year, but they practically had nothing to work on.

For the encouragement of the beginner in bee-keeping I wish that I might tell of having harvested a record crop from these

bees that were purchased in old, dilapidatel hives and transferred to new workable hives. Unfortunately, however, I cannot make any such record and tell the truth. And as a document of this sort should be primarily truthful, I must simply say that the honey crop for the season was almost a total failure. At the end of the honey flow I had to my credit barely one pound of surplus honey per colony; some colonies having yielded as high as fifteen pounds and many others yielded nothing at all. In a favorable season an apiary of this size could very readily be managed so as to yield an average of 100 pounds per colony. The experienced beekeeper will realize what an exceedingly poor season we had when I say that the bees made practically no effort to swarn and that the only swarms which issued were two that escaped during the fruit bloom. After these two early swarms there were no more attempts at swarming on the part of any of the colonies in the apiary. This, of course, reduced the work of looking after the apiary to a very material extent. This is a brief record of the starting of what I intended to be an experimental apiary. The first year's work has been a failure through no fault of the operator, and while not a great deal has been learned the season has been rich in experience.

One of the interesting things observed early in the season was that honey dew is not necessarily of dark color. There was a considerable quantity of very light honey dew stored early in the season and it very closely resembled the honey produced from the white clover. Honey dew, it should be understood, is not strictly a bee product, but is gathered by the bees and stored by them. It is, in fact, a secretion from the plant lice and it is not salable as honey under the pure food law. It must be labeled as honey dew and sold as such. Under the law honey is defined as being a product made by the bees from the nectar of flowers, and the pure food chemists are enabled by their scientific instruments to determine whether a sample of honey contains honey dew or whether or not it contains such substances as cane sugar or glucose.

The wise beekeeper, however, does not attempt to adulterate his product with any of these preparations for several reasons. In the first place they are not honey and his product would not gain the same reputation that it would if marketed as a strictly pure preparation. In the second place it does not pay from the money standpoint to adulterate honey. This, I believe, has been demonstrated repeatedly by other writers, so that I need not go into the actual figures in the matter. In the third place there is too great

a certainty of prosecution after the detection is made by the health authorities. The wise beekeeper will stick to the pure product and will endeavor to build up a reputation for selling only strictly pure and honest goods, and will, in the long run, increase his market and ultimately increase the price which he receives for his goods.

During the season I had an opportunity to visit a number of very interesting apiaries in different parts of the State. One of

APIARY OF MASON NIBLACK.

the most intersting of these is the apiary of F. B. Cavanaugh at Hebron, Ind. Mr. Cavanaugh has about six hundred colonies of bees and he operates his apiary not only for extracted honey, but for comb honey as well. He has an almost ideal plant, and has probably the largest apiary in the State. Mr. Cavanaugh is thoroughly modern in his ideas and employs a power machine for extracting his honey and also uses a large automobile in going from one apiary to another. He has several outyards which he operates in this way. He also has a convenient truck which he can attach on the back of his automobile, and in that way can haul large loads of honey or bees in a very short time.

Another very interesting little apiary which I had the pleasure of visiting was owned by Mr. Mason J. Niblack of Vincennes, Ind.

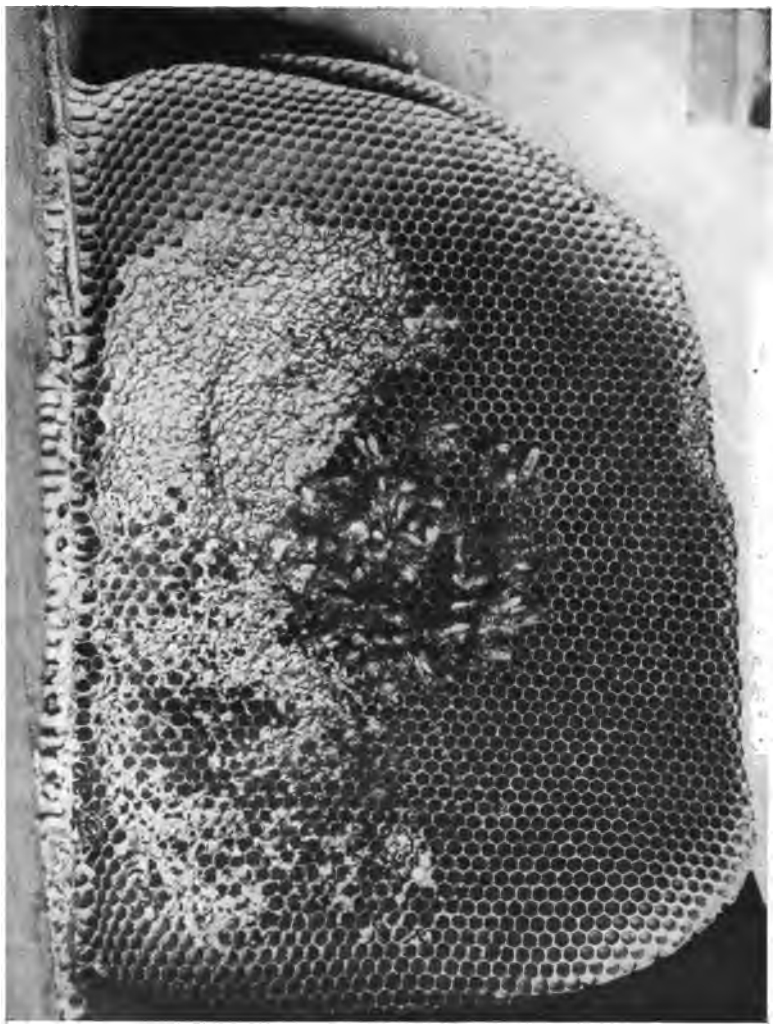
Mr. Niblack's apiary is located in a beautiful and somewhat romantic spot southwest of the city. As will be seen from the accompanying illustration, Mr. Niblack has only a small number of colonies, which he operates because of the pleasure he derives from handling the bees. He prefers the ten-frame hive and operates his apiary for comb honey exclusively. The spirit of commercialism does not enter into Mr. Niblack's work. As he says, he keeps

MAKESHIFT HIVES.

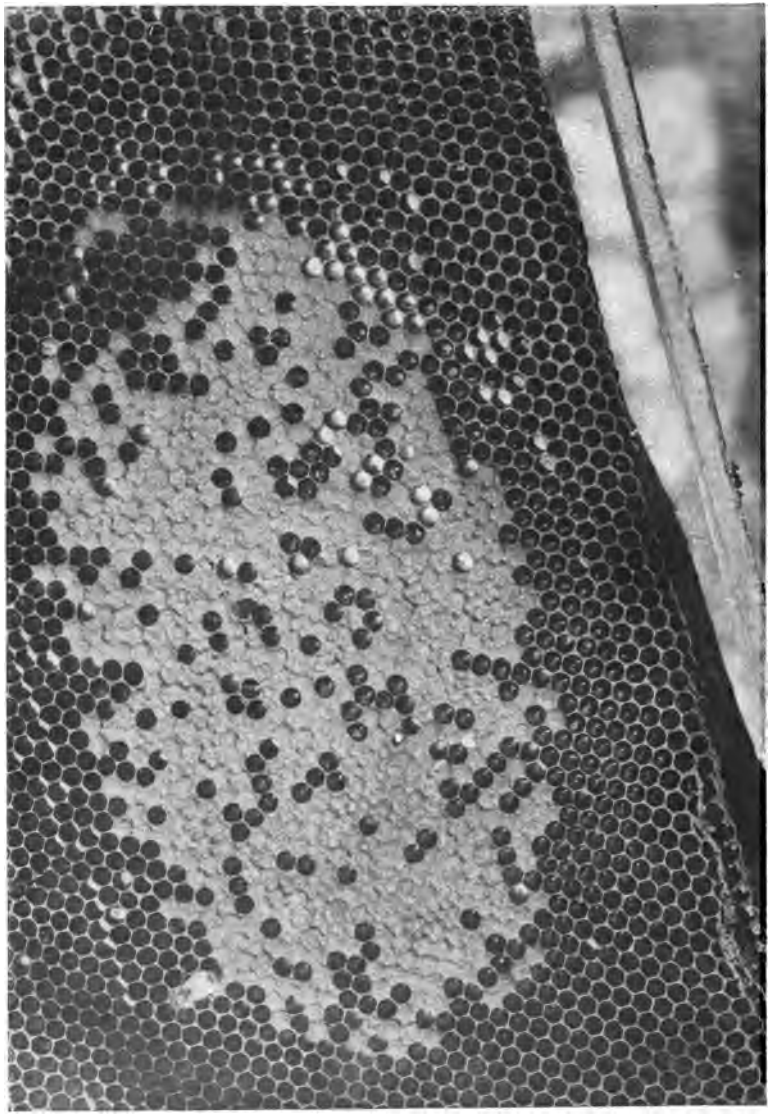
The owner used what he had at hand at swarming time. Good hives should be ordered in advance and then the beekeeper will not have to transfer the bees from there crude hives.

the bees because he likes to eat the honey, and this is the motive that prompts a great many beekeepers over the State of Indiana to run the risk of stings in order to secure their choice sweet. Mr. Niblack, however, is thoroughly scientific in his work and gets a great deal of pleasure out of handling his bees.

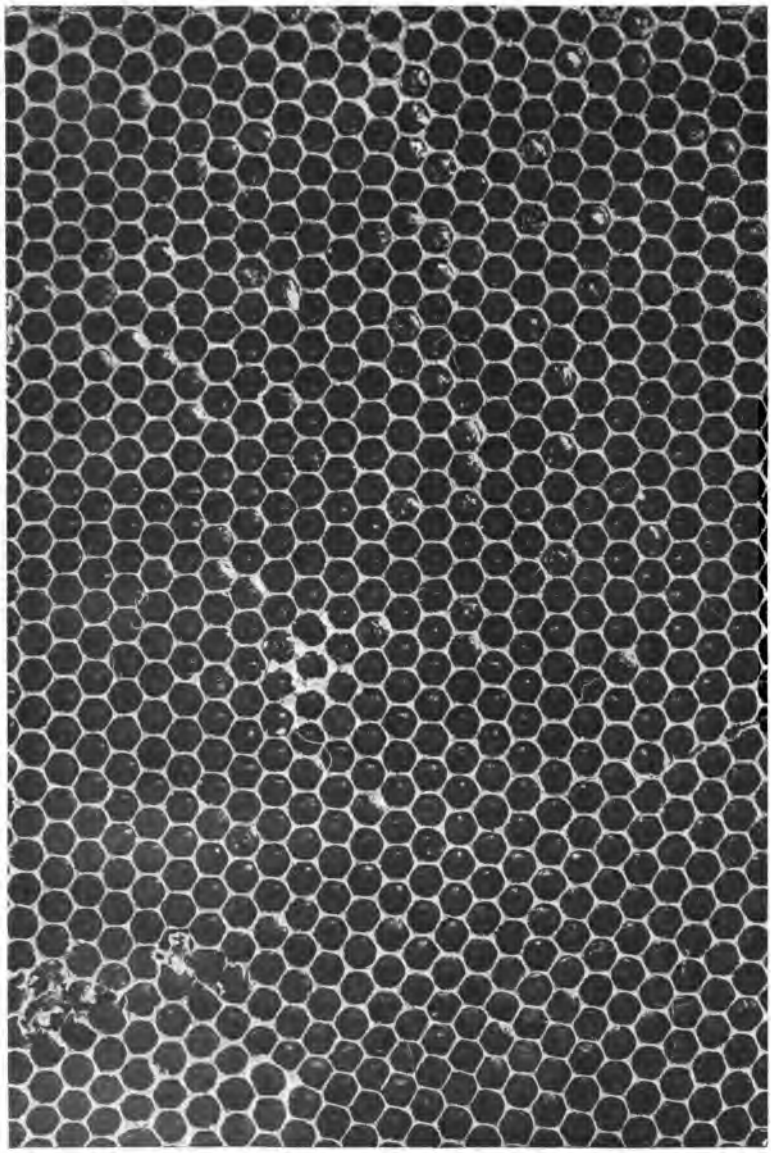
I saw another interesting little apiary, of which I will include a photograph, showing a very unique sort of homemade hive. The hives, however, can scarcely be called homemade, as they were bought already made, being simply disused nail kegs, and the supers consist of an empty candy pail turned over the nail keg. To my very great surprise, the bees in these makeshift hives were in a healthy condition and had actually stored some surplus honey. The owner realized that the hives were not the best thing for his bees and has already prepared to transfer them to good new hives.



STARVED TO DEATH WITH HONEY IN REACH.



THIS REMARKABLE PHOTOGRAPH SHOWS A COMPLETE LIFE HISTORY OF THE HONEY BEE FROM THE EGG TO THE ADULT.



A FRAME SHOWING FOUL BROOD.

The diseased matter is in the form of small scales that adhere to the cwer side of the cells.

HIVES IN A MODEL APIARY.

THE TREATMENT OF FOUL BROOD DISEASES OF BEES.

In my second annual report, Mr. George S. Demuth gave a very excellent account of the treatment of foul brood. This report is now out of print, but the demand for the information not only continues but increases with each succeeding season. Accordingly, I will include in this report the following brief account of a simplified method of handling foul brood.

At the time of the publication of the second annual report the recognized treatment of foul brood consisted of what was called the double-shaking treatment; that is, the bees were shaken from the diseased combs into clean, new hives and were allowed to build comb for four days and were then shaken the second time into hives containing full sheets of foundation. This second shaking is now done away with. The diseased colony is set aside and a clean, new hive is set in its place. This new hive must have the frames fitted with one inch strips of foundation; never with full sheets. The frames from the diseased colony should be removed one at a time and should be carefully examined as they are removed, to find the queen. The queen should be handled carefully and should not be brushed off in the rough fashion in which the worker bees are handled. I believe that it is better practice to brush the bees off the combs than it is to shake them. Very often in shaking the bees off, some drops of honey will be shaken off with them, and it is desired that they carry into their new hive just as little of their old honey as possible. A very good brush for this purpose is made from some stiff grass, simply gathered into a small bunch and afterwards burned. It is almost impossible to disinfect a bee brush satisfactorily, so that a makeshift brush consisting of a bunch of grass is far more satisfactory. The combs should be taken out and the bees brushed from them into the new hive, and as soon as they are cleared of bees they should be placed in a tub or other receptacle containing water, so as to prevent the bees gathering on the combs and taking back any of the old honey. This placing of the brushed combs in the water will also prevent bees from neighboring colonies robbing out any of the disease-infested honey. It is well, also, to do this work late in the evening, so that the bees from other colonies will be flying just as little as possible. After the bees have been brushed into the new hive it will be advisable to place a queen-excluding zinc over the front of the hive in order to prevent the queen from coming out with the swarm. In some cases the bees will attempt to swarm

OPENING THE HIVE.

LOOKING FOR FOUL BROOD.

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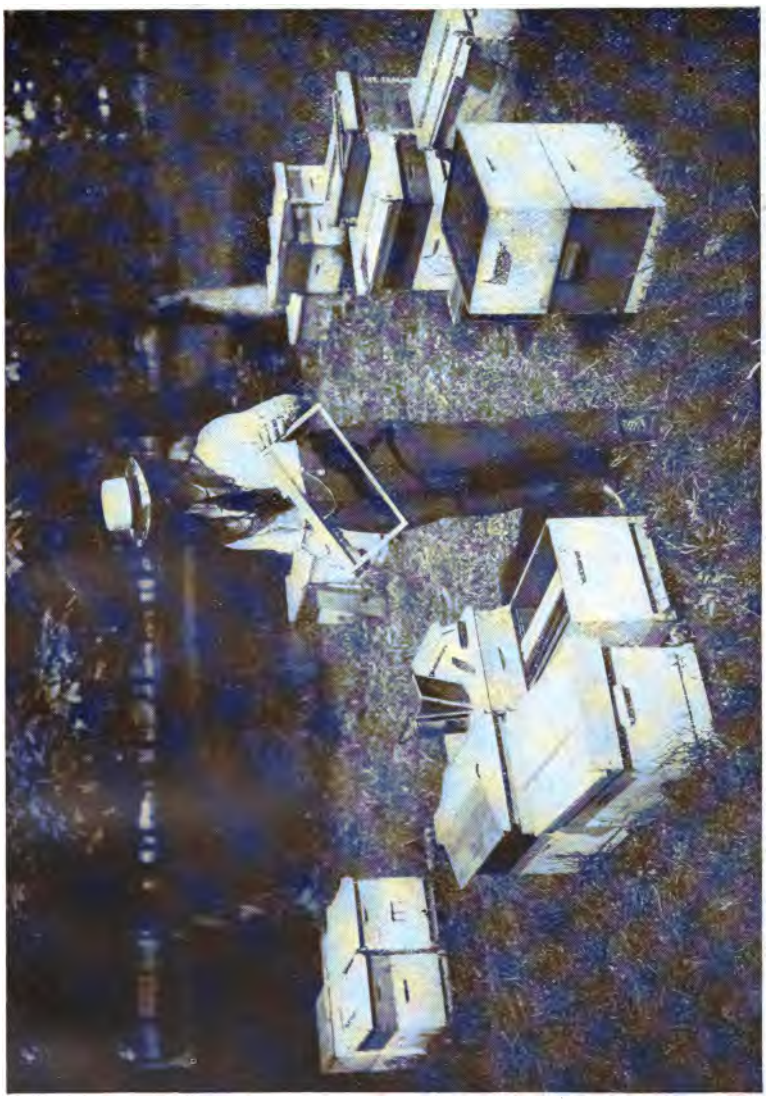
out if this is not done, although many cases have been treated without the use of any queen guard placed at the entrance. The object in shaking the bees from the old combs is to remove from the colony all possible sources of infection.

The American foul brood is known to be a bacterial disease, and it is supposed that European foul brood is of a similar nature, although this is not generally known as yet. These, in each case, attack only the brood; that is, the lrava of the bee, and never the adult bee. The following extract regarding the nature of the bee diseases is taken from Dr. Phillips' Farmers' Bulletin No. 442:

"There are two recognized infectious diseases of the brood of bees, now known as American foul brood and European foul brood. Both diseases weaken colonies by reducing the number of emerging bees needed to replace the old adult bees which die from natural or other causes. In neither case are adult bees affected, so far as known. The means used by the beekeeper in deciding which disease is present is the difference in the appearance of the larvae dead of the two diseases. That the diseases are entirely distinct cannot now be doubted, since they show certain differences in the age of the larvae affected, in their response to treatment, and in the appearance of the dead larvae. This is made still more certain by a study of the bacteria present in the dead larvae. Reports are sometimes received that a colony is infected with both diseases at the same time. While this is possible, it is not by any means the rule, and such cases are usually not authentically reported. There is no vidence that chilled or starved brood develops into an infectious disease or that dead brood favors the development of a disease.

NAMES OF THE DISEASES.

"The names, American foul brood and European foul brood, were applied to these diseases by the Bureau of Entomology of this department to clear up the confusion in names which formerly existed. By retaining the words 'foul brood' in each name the disease-inspection laws then in force could be interpreted as applying to both diseases. These names were in no way intended to designate geographical distribution, since both diseases did exist and do now exist in both Europe and America, but were chosen primarily because they were convenient and easily remembered names. Their only significance is in indicating where the diseases were first seriously investigated. It was particularly desirable to



THE OLD HIVE IS SET ASIDE AND A CLEAN ONE IN WHICH THE FRAMES ARE FITTED WITH STRIPS OF FOUNDATION IS PUT IN ITS PLACE.

THE BEES ARE SHAKEN OFF THE DISEASED FRAMES INTO THE CLEAN HIVE.

change the name of the disease now known as European foul brood, since 'black brood' entirely fails to be descriptive and is misleading."

A condition known as pickled brood sometimes exists in the apiary and very frequently leads the beekeeper to suppose that his bees are affected with some form of foul brood. This disease is not supposed to be contagious and the exact cause of it is not known at this time. One of the most characteristic features of the brood that dies under the condition known as pickled brood is that the head end of the larva always turns up, producing what is termed the "Chinaman's shoe" condition.

The following table of comparative symptoms will enable the beekeeper to determine something of the difference in bee diseases which may be present in his particular apiary:

AMERICAN FOUL BROOD.	EUROPEAN FOUL BROOD.	PICKLED BROOD.
Color at first, light chocolate.	Color at first, yellow.	Color at first, light yellow.
Darkens with age until dark brown.	Darkens with age until almost black.	Darkens to brownish color.
Dead larvæ become shapeless mass on lower side of cell.	Dead larvæ may become shapeless mass but very young larvæ may remain coiled in the bottom of the cell.	Dead larvæ usually retain shape, though swollen.
Attacks larvæ about time of capping or soon after.	Attacks larvæ before time of capping (usually.)	Attacks larvæ about time of capping
Combs show sunken and perforated cappings; discolored.	Very seldom show sunken and perforated cappings.	Cappings may be perforated but not discolored.
Dead material is ropy. Larvæ dies down to tightly adhering scale.	Ropiness almost or entirely wanting. Dried larvæ form scales not tightly adhering to cell.	Never ropy but is watery. Usually removed.
Odor is foul, noticeable even when a few cells are diseased.	Odor not noticeable except in most advanced stages when it resembles odor of American Foul Brood.	Very slight odor.
Seldom attacks drone or queen larvæ.	Disease attacks drone and queen larvæ among the first.	
Spreads slowly.	Spreads rapidly.	Supposed not to be contagious

INSPECTION WORK.

Bee inspection work was started in March of the present season and continued until October. A total of twenty counties was examined, with a total of 2,076 colonies inspected. Out of these colonies, 183 were found to be diseased with American foul brood, 199 with European foul brood and twenty-three with pickled brood.

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